THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 15 NOVEMBER, 1936 Number 11

COMMODORE S. O. RICHARDSON, JR.

Inventor of the Westlake bulb machine and vacuum process for gathering glass. For story see page 403.

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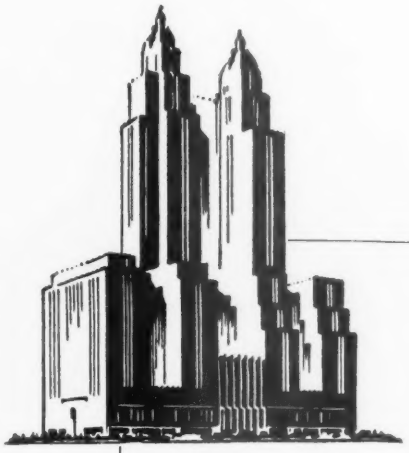

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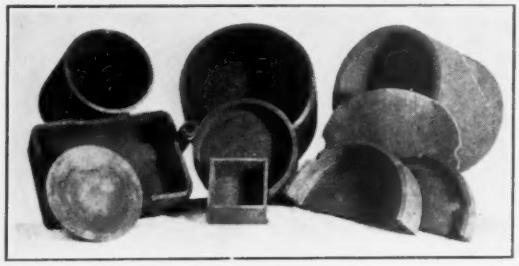

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Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
The Seaboard Feldspar Co.
The Vitro Mfg. Co.

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Kentucky Clay Mining Co.
Spinks Clay Co., H. C.

Flint
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.

Flint Pebbles
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Consolidated Feldspar Corp.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Floors (Non-Slip)
Norton Co.

French Flint
Consolidated Feldspar Corp.
Paper Makers Importing Co.

Frit
Allied Engineering Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Fuel Oil Systems and Control, Stokers
Bethlehem Steel Co.
Simplex Engineering Co.

Furnaces
Allied Engineering Co.
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Simplex Engineering Co.

Glass Bending Ovens, Glass Decorating Machines
Simplex Engineering Co.

Glass Equipment
Hartford-Empire Co.
Lancaster Iron Works, Inc.

Glass Melting Pots (Open and Covered)
Pittsburgh Plate Glass Co.

Glass Melting Tanks and Furnaces
Pittsburgh Plate Glass Co.
Simplex Engineering Co.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Goggles
Willson Products, Inc.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc. R. H. & Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Dept.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Co.

Granulators
Hardinge Company, Inc.
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

Hearths
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Crystolon*)

Hearths (Fused Al_2O_3, SiC)
Electro Refractories & Alloys Corp.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.

The Hommel Co., O., Inc.
Paper Makers Importing Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kellog AA Refractories
Electro Refractories & Alloys Corp.

Kilns, China (Decorating)
Allied Engineering Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Simplex Engineering Co.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide)
Electro Refractories & Alloys Corp.

Kyanite
Celo Mines, Inc.

Kryolith
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Electro Refractories & Alloys Corp.

Lehrs
Simplex Engineering Co.

Lehrs (Electric or Fuel Heated)
Simplex Engineering Co.

Lehr Loaders
Simplex Engineering Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.
The Vitro Mfg. Co.

Magnesia (Fused)
Electro Refractories & Alloys Corp.

Magnesia (Sintered, Calcined)
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Norton Co.
The Procelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Masks (Breathing)
The DeVilbiss Co.
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers (Batch)
Lancaster Iron Works, Inc.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
Allied Engineering Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.
Simplex Engineering Co.

Muffles (Laboratory)
Electro Refractories & Alloys Corp.

Mullite (Refractories)
Electro Refractories & Alloys Corp.

Muriatic Acid
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Non-Gro Refractories
Electro Refractories & Alloys Corp.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Potters Supply Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Polariscopes
Bausch & Lomb Optical Co.
Simplex Engineering Co.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Hardinge Company, Inc.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Simplex Engineering Co.

Pug Mills
Lancaster Iron Works, Inc.

Pyrophyllite
The Seaboard Feldspar Co.

Pyrometer Tubes
Carborundum Co.
Electro Refractories & Alloys Corp.
Montgomery Porcelain Products Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.

Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation

Raw Material Handling Equipment
Simplex Engineering Co.
Lancaster Iron Works, Inc.

Refractometers
Bausch & Lomb Optical Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Kentucky-Tennessee Clay Co.
Norton Co.
Pittsburgh Plate Glass Co.

Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Kentucky-Tennessee Clay Co.
Norton Co.
Pittsburgh Plate Glass Co.
Titanium Alloy Mfg. Co.

Represses (Automatic)
Lancaster Iron Works, Inc.

Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
The Hommel Co., O., Inc.
Willson Products, Inc.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Potters Supply Co.

Salt Cake
American Potash & Chemical Co.
The Hommel Co., O., Inc.

Sandblast Helmets
Willson Products, Inc.

Sand Grinder and Sifters
Lancaster Iron Works, Inc.

Saponin
The Hommel Co., O., Inc.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Silicon Carbide
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Electro Refractories & Alloys Corp.

Sillimanite (Synthetic)
Pittsburgh Plate Glass Co.

Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp
Ingram-Richardson Mfg. Co. of Indiana, Inc.

Norton Co.
Pittsburgh Plate Glass Co.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Soot Blowers
Simplex Engineering Co.

Special Machines
Simplex Engineering Co.

Spar
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Spray Booths
The DeVilbiss Co.

Spraying Equipment
The DeVilbiss Co.

Spurs
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Stilts
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.

Tanks
Simplex Engineering Co.

Tank Blocks
Corhart Refractories Co.
Pittsburgh Plate Glass Co.

Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.

Tile (Floor)
Norton Co.

Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.

Tile (Wall)
Denver Fire Clay Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Trucks
Lancaster Iron Works, Inc.

Tubes (Insulating)
Carborundum Co.
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.
Pittsburgh Plate Glass Co.

Uronium Oxide (Yellow-Orange-Black)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Vitro Mfg. Co.

Water Softening Plants
Simplex Engineering Co.

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Winding Drums
Lancaster Iron Works, Inc.

Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

North Carolina Feldspar
North Carolina China Clay
Georgia China Clay

Representing: Georgia Saggar Clay

North Carolina Feldspar Corp.
Carolina China Clay Co.
Boyd & Sant Clay Co.
John Sant Company

Pulverized Saggar Grog
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FUEL DATA
for a Large Continuous Bridgewall Tank

Total Days Life (to date)	574	Total Gas to Hold Temperature for Total Idle Days (M)	81,954
Total Producing Days	400	Total Gas Consumed on Operating Days (M)	321,872
Total Glass Delivered (Tons)	44,524	Melting Area Sq. Ft.	627
Total Gas Consumed (M)	403,826	Tons Glass Pulled per Operating Day	111.3
Useful Gas 3000 X Glass Produced (M)	133,572	Rating Sq. Ft. Ton/Day	5.63
Total Gas to Hold Temperature (M)	270,254	Cu. Ft. Gas per Ton of Glass	7,230
Gas to Hold Temperature per Day (M)	471		

WHAT DETERMINES FUEL PERFORMANCE?

ONE of the questions frequently asked the manufacturer of tank blocks is: "What kind of fuel performance can I expect in connection with your products?" That, of course, is a question to ask the tank designer and operator—NOT the supplier of the blocks.* But tabulated above are the fuel figures for a large bridgewall type continuous furnace melting clear flint soda-lime glass—figures which are more or less typical of *properly-designed* tanks, regardless of the materials with which they are constructed. The sidewalls from doghouse to machines were Corhart. The figures are *not* for some small "spot period"—they are for the first 574 consecutive days of the campaign.

***The fuel efficiency of a glass furnace is a matter of engineering, design and operation. It is not a function of the particular materials of which its sidewalls are constructed.**

☆ ☆ ☆

Studies of fuel performances in various plants and on various fuels show conclusively that furnace design and operation are the controlling factors in fuel efficiency. We would welcome an opportunity to discuss the subject with you. *Address:* Corhart Refractories Co., *Incorporated*, 16th and Lee Sts., Louisville, Ky. *In Europe:* L'Electro Refractaire, Paris. *In Japan:* Asahi Glass Co., Tokio.

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A Monthly Publication Devoted to Proceedings of the Society and Promotion of Coöperative Research of Technical, Scientific, and Art Questions

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PAPERS

IS STAINED GLASS A LOST ART?*

By Lawrence Saint

An Age of Color

Today we live in an age of color. The invention of neon signs and kindred illuminated signs have made colorful the streets of our cities and villages. We find that color has invaded the kitchen and bathroom, with pink bathtubs and blue sinks, and all sorts of colored toothbrushes.

As stained glass is the greatest expression of color in any art, it ought to be the leader in this movement in which we find ourselves, and it is appropriate that we should study it.

Stained glass transfixes the myriad flashes of the diamond, the glory of the sunset, the iridescence of long buried ancient glassware, the splendor of a New England autumn, the richness of Venetian sails at evening, the gleam of a thousand jewels, the wonder of the rainbow.

The iron work used in stained-glass windows subdivides the weight of the lead and glass. It is made as nearly as possible like the iron work used by the ancients, because the eye and key system allows the panels to be easily removed if need be and put back. I use Swedish-charcoal wrought iron, the same type as the old, for its lasting qualities. I have seen much of this iron seven hundred years old.

There is an interesting unity of materials in a stained-glass window; for instance, the copper of the wires (which fasten the tiny supporting bars to the window to assist against wind pressure) as one oxide, makes greenish blue and, in another form, red. Iron is also used as a coloring element in the glass. There is lead in the cement and glass as well as in the grooved leads which bind the window together. There is tin in the glass and in the solder. The building is limestone. There is lime in the glass. The materials pull together quite happily.

The ancients cut glass by running a hot iron over it, dampening the trail to make a fracture, and then "groising" or "chewing" it down in some way. By using the notches on the modern cutting wheel, I have reproduced the exact effect seen on the edges of old glass. It is quite likely this notched part of the tool has come down from ancient times. The tiny wheel used today when passed over the glass causes friction, making fractures in the glass. When tapped on the back the glass breaks where it has been scored by the wheel. This method is superior to the old.

Glass paint of the 13th Century is a most wonderful substance. I have seen examples on the outside of a window which had resisted the weather for 700 years; there is some 800 years old just beginning to come off the glass. With the sun shining through it under a microscope, it looks like a sunset. It has in it particles of pale lemon color, yellow, orange, deep red, brown, and black, and has a luminous quality like Rembrandt's shadows, which gives life and glow to the windows.

*Presented at the Annual Meeting, American Ceramic Society, Columbus, Ohio, March 30, 1936 (General Session). Received May 20, 1936. Copyright 1936 by Lawrence Saint.

See also Lawrence Saint, "Stained Glass Creed," *Bull. Amer. Ceram. Soc.*, **15** [6] 238–41 (1936).

Color Glass Production

When I undertook the work for Washington Cathedral it was understood that I would make my own glass. I was expected to get colors like those in the old glass. Although I had collected a number of formulas from different countries, I found it necessary to have analyzed several pieces of 13th Century glass. Analyses by the quantitative* and the spectroscopic† systems checked beautifully. I was surprised to learn that there were materials in the glass of which I had never heard. The reports showed silica, alumina, chalk, magnesia, copper, soda, potash, manganese, sodium sulfate, titanium, cobalt, bone-ash, iron, lead, tin, and borax.

In the piece which was analyzed, I discovered the secret of how to reproduce almost any shade of blue I wanted. Altogether I have made about 300 shades of blue. I took samples of my glass to Europe, many shades of all colors, to compare them with the old. About 75% of the samples closely approximated the best colors in the old windows.

I found that by combining manganese with other coloring elements I could produce soft Tokay-grape shades, used in drapery and flesh tones.

The old colors are never raw or garish or unpleasant. They are soft and poetic and beautiful, like the lovely colors of apples and banana skins and Tokay grapes, the sky and autumn leaves and old lace. To produce a fine yellow, for instance, we find it necessary to borrow a little from the red and a little from the blue, which makes purple. A slight amount of purple superimposed on the yellow produces the soft banana or topaz tint. This softened or slightly neutralized tint will harmonize with the other stronger colors about it.

The same thing happens to the red. It borrows a little yellow and a little blue, which makes green. And a little of the green with the red softens the red and makes it blend beautifully in the field with other contrasting colors. The same thing is true of the blue. A little yellow and a little red makes it harmonize with yellow and red. How this effect is achieved in the red will be described later.

I believe the system of color harmony used by the medieval artists to be fundamental. It is the basis of color harmony in oriental rugs, Japanese prints, and Venetian paintings. The same principle was used in making tapestry and, in fact, in all forms of good art in all countries and all ages.

Soft shades of topaz yellow and attractive shades of red and blue result from mixing in small amounts of their complimentary colors.

Effect of Color Layers

In a photomicrograph* of the edge or section of a piece of ancient red, dating from 1225 (Fig. 1), the black streaks are the red layers. The ancient red, unlike the other colors which were and still are colored uniformly through their mass like gelatin, was made with a number of microscopic layers running throughout its body. Frequently

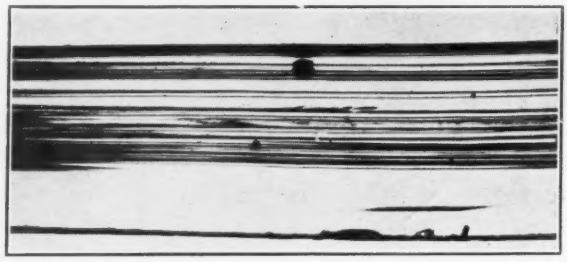

Fig. 1.—Photomicrograph of a cross-section of a piece of red glass made about A.D. 1225 showing typical arrangement of the red in layers. Magnified about 15 diameters.

it had amber-colored layers between the layers of red and on the back a layer of greenish white varying in thickness and tint. The variation of the greenish white and the amber as well as the amount of red determined the different shades of red. A red from my formula, which I think closely matches the old stained glass if allowance is made for the aging in the old one, has 16 layers (Fig. 2). The piece of red glass made about A.D. 1225 (Fig. 1) measures one-eighth inch thick. It has an irregular surface caused by the weathering of the glass. In cross-section its red layers appear black with amber layers between and greenish white on the back.

Ordinarily the layers run parallel, but in exceptional cases this is not true. I never had seen such an arrangement of layers until these were ground down.

One of the finest samples of glass made in ancient times has some patina (pit marks and corrosion caused by the weather) which makes it a

* Frederick Wynkoop.
† Jacob Papish.

* Howard A. Walter.

little gray. Along the clear edge the actual color may be seen; there are about twenty layers of red.

My red formula covers nearly eight pages of typwritten material and there are about forty ways it can fail. I arrange the layers in a little different way from the ancient, but the effect achieved is the same.

After 200 years, the art of making good red glass had practically vanished. "Flashed ruby" from the 15th Century is without streakiness or striations. One layer of red was flashed on a nearly white body of glass. By this time the glory of the early reds had departed; the entrancing loveliness was no more.

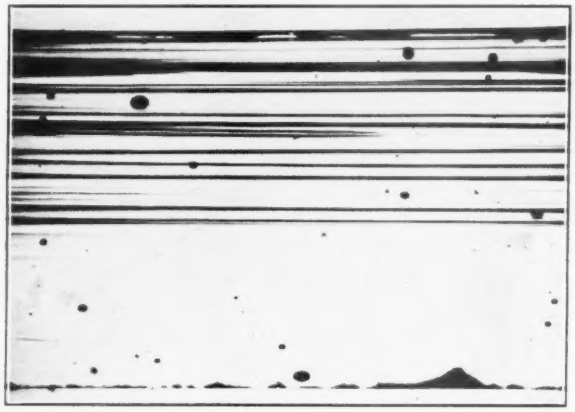

Fig. 2.—Photomicrograph of a cross-section of a piece of red glass made from Lawrence Saint's formula, showing the layers.

I tried all sorts of variations and combinations of the red made from my formula. Sometimes what should have been red came out black; sometimes no color showed. Sometimes I would find a lump of free copper about the size and shape of a lima bean in the bottom of the pot. By varying the amount of red and greenish white or amber layers, I can now produce an infinite variety of shades in the red.

Effect of Irregular Thickness

One of the interesting things about old glass is that nearly every piece varies in thickness. This irregularity of thickness bends the light rays in a way that is pleasing to the eye. On the principle of enlarging and reducing lenses, the rays of light change in all directions, giving a certain soft effect to the old windows. Not only does this irregularity of thickness bend the light rays, but it helps the beauty of the tint of the glass by making it light and dark in the same piece. In a piece of old blue, rather the worse for wear, which has stood up against the rains and frosts and snows for seven centuries, the center of the glass is thinner and therefore lighter than the outside which is thicker and darker. In this particular piece of glass, the rays radiate as they do from a reducing lens.

One of the peculiar characteristics of 13th Century blue is that where it is thick it looks purplish-blue and where it is thin it has a greenish-blue tint.

Effect of Weathering

Some people think that glass lasts forever, but in time it is attacked by the weather. The weathering really enriches the vibration of the glass, if it has not gone too far, and gives it a delightful shimmering effect. To retain this sparkle or vibration, I have studied the corrosion and pitting to find some way of reproducing the effect by craftsmanship. The question is often asked whether the beauty of old glass is not largely due to the weathering or aging. This is true only up to a certain point. Glass that has too much weathering is almost rotted away. It is about one-sixteenth inch in thickness. Horizontal leads often make a miniature roof which keeps the rain off the glass immediately beneath; thus protected, it remains clear at the top.

Glass Painting as an Art

In painted glass of Medieval times, the lines taper in width and are light and dark in value. Edging the brown, painted lines is an almost invisible, horny-toned film which keeps the lines from looking too thin as the light pours around them.

When a rich color scheme was used it was necessary to paint the whites down by putting rich design work on them. Everything was done free hand. It is delightful to imagine the enjoyment the early artists must have had in their clever brush work. It has snap and life in it.

Textures are an important quality in art. The waves are a texture on the ocean; bark is texture on trees; clouds are a texture on the sky.

Examples of Glass Windows

In Europe I have climbed around on ladders and scaffolding studying and copying the windows to learn the character of the glass, the type and method of leading, painting, and so forth.

The west windows in the Cathedral of Chartres

are the greatest windows in all the world. Inside the cathedral is seen one thousand square feet of the most astonishing color, majestic design, and thrilling Christian story that could possibly be imagined. As a Christian artist I am happy that the greatest windows have as their theme the life of Our Lord.

The crucifixion window at Poitiers, France, is one of the greatest in the world. The figure of Our Lord on the cross is eight and one-half feet high. The colors are magnificent. A great glass development occurred in Poitiers dating from Roman times. A Grecian figure which was dug up there may have been eagerly studied when this window was made (in 1172). The treatment in the drapery on the statue and in the window is much the same. The reds are marvelous in striations and color tone. It was here that the idea of making windows sensitive to light first came to me.

It was when the early windows of the 12th Century were able to combine something "to keep out the birds and rain and yet admit the light," to depict the Christian story, and to embellish a cathedral architecturally that they caught the imagination of the people. The populace spent fabulous sums, relatively speaking, on their windows, and they were as enthusiastic about them as we are about radios and cars today.

In the west windows of Chartres, Our Lord is represented in several scenes. These 12th Century windows shimmer and glow and change somewhat with every passing cloud and shadow and every changing tint of blue in the sky. The paint on these windows has lasted for centuries.

Another part of the same series of windows shows Our Lord in large scale at the top of the window. A minister who looked at this window said that it was the most celestially beautiful thing he had ever seen in this world. This window is sensitive to light, changing with each passing mood of the sky behind it, because the colors are neither extremely dark nor extremely light.

The first glass I made was not well melted, but when I went abroad to compare it I found that the blues from the first dozen pots matched closely the blues in the Tree of Jesse Window at Chartres, perhaps the most famous window in the world. Once in a while we do have a good accident.

Stained Glass Should Harmonize with Building Architecture

It is important to know that stained glass should accept the limitations of the architecture. It should fit harmoniously into the architectural scheme and seem to grow out of it. It should not fight the architecture, as many modern picture windows do. The windows in the Chartres clerestory feel naturally the shape, lines, and majesty of the great spaces of stone in this mighty House of God.

Some three of four years ago, James Sheldon of New York became so enthusiastic about the windows in the Cathedral of Leon in Spain that he, through Washington Cathedral, sent me over to see them.

The Spaniards used color in a different way from the French. They emphasized the reds, yellows, and greens and reduced the blues. This was quite a different view on color construction from anything I had had before. The areas of color in the window from Leon are divided about as follows: 23% red, 23% blue, 16% yellow, 12% white, 10% green, about 8% Tokay grape, and 3% flesh. The division irons and leading are not included. So large is the area of glass in the walls of Leon that they seem to be made of glowing color.

In the 14th Century someone discovered how to make a golden color out of silver. By dissolving silver in acid and firing it on the glass at a temperature of 1000°F or more, it becomes a transparent yellow. It is the only material used to stain glass after it is made. This discovery may have been a determining factor in 15th Century stained-glass work. It enabled the windows to have warmth of tone despite the cool colored glass used. Perhaps, too, the soft skies and weak light of England help to account for the English artists forsaking the rich color schemes of France and using so much white glass. No doubt the latitude, also, has a bearing on the type of windows used.

Some people think that patina or aging is what makes the old windows beautiful. If the patina has been ground off of old glass and compared with usual samples, those with patina have more depth, more grayness and softness, but the colors basically are delicate and beautiful. I have never seen an ugly one.

The whites of the old windows are very soft. They have a hint of moonlight in them. Makers

of automobile headlights should try this tint. It would take away much of the distressing glare.

Figure 3 is a drawing of a panel for my first window in Washington Cathedral. The value of symbolism should be emphasized, because symbolism is the language of stained glass. It is the "boiled-down" essence of an idea. In this drawing the wheat represents thirty-, sixty-, and one hundred-fold. The birds are treated in a decorative way. The thorns are shown growing up and choking the wheat.

In the "Ten Virgins" panel, I tried to show the spirit of the subject in the contrasting movement of the figures.

The old artists made their designs fit into the various limitations of space. The figures bend in the rounding space of a medallion. In designing the water, I studied the Japanese treatment of whitecaps and the medieval structure of waves.

The theme of the Rose Window (Fig. 4)[1] that I designed for Washington Cathedral is the Last Judgment. The window is $26\frac{1}{2}$ feet in diameter, 256 square feet in area, contains 9000 pieces of glass, has 79 figures in whole or in part, and took twelve persons about a year to execute it. Frohman, Robb, and Little were the architects. I had less trouble with this window than any other. The red note in the Rose Window, about 19% of the whole, was determined by the Lake of Fire panel. I had considerable difficulty with this panel. Throughout the window all sorts of varying combinations of color are used, although the same general design elements repeat themselves. Everything is varied and is done free-hand; no two pieces are exactly alike. I learned much about this technique at Leon.

The Rose has in it eighty different shades of blue, unnumbered shades of red, fifty of warm and cool greens, fifty-three of greenish white, forty or more of yellow, twenty-three of flesh tone, and thirteen shades of lavender and purple. Primary colors dominate in area.

Symbolic Simplification

One of the things essential to the stained-glass art is conventionalization, or symbolic simplification. We do not treat heads and figures in full form, naturalistically, as is done in photographs. We outline the boundaries—put strong lines around the brow, eyes, nose, lips, ears, and chins. We try to interpret rather than imitate nature. I worked for several years to see if we could copy nature exactly and conventionalize it, but gave it up.

Bold lines running almost parallel at a great distance give the effect of real hair. At the same time the character of the glass is preserved.

In the figure of Jeremiah, I tried to show the melancholy sadness of this great servant of God. In making King David, I had trouble with the yellows in the robe. Finally I tried a yellow that was marked "not useful" and got the desired result.

Fig. 3.—Cartoon for Parable Window of the "Sower," Washington Cathedral by Lawrence Saint.

The head of St. Paul in a panel of the Parmelee windows, three windows under the north transept Rose in Washington Cathedral, is shown on actual glass, full size, with artificial light behind it. It illustrates what I mean by outlining the boundaries and tapering the painted lines, making them light and dark in value. The panel is located 45 feet above the floor and is seen from a maximum distance of 179 feet. The striations in the red in the panel have design energy, mak-

[1] This photograph by Gerald W. O'Connor was taken at a hazardous risk, and Mr. O'Connor is to be congratulated on the splendid result.

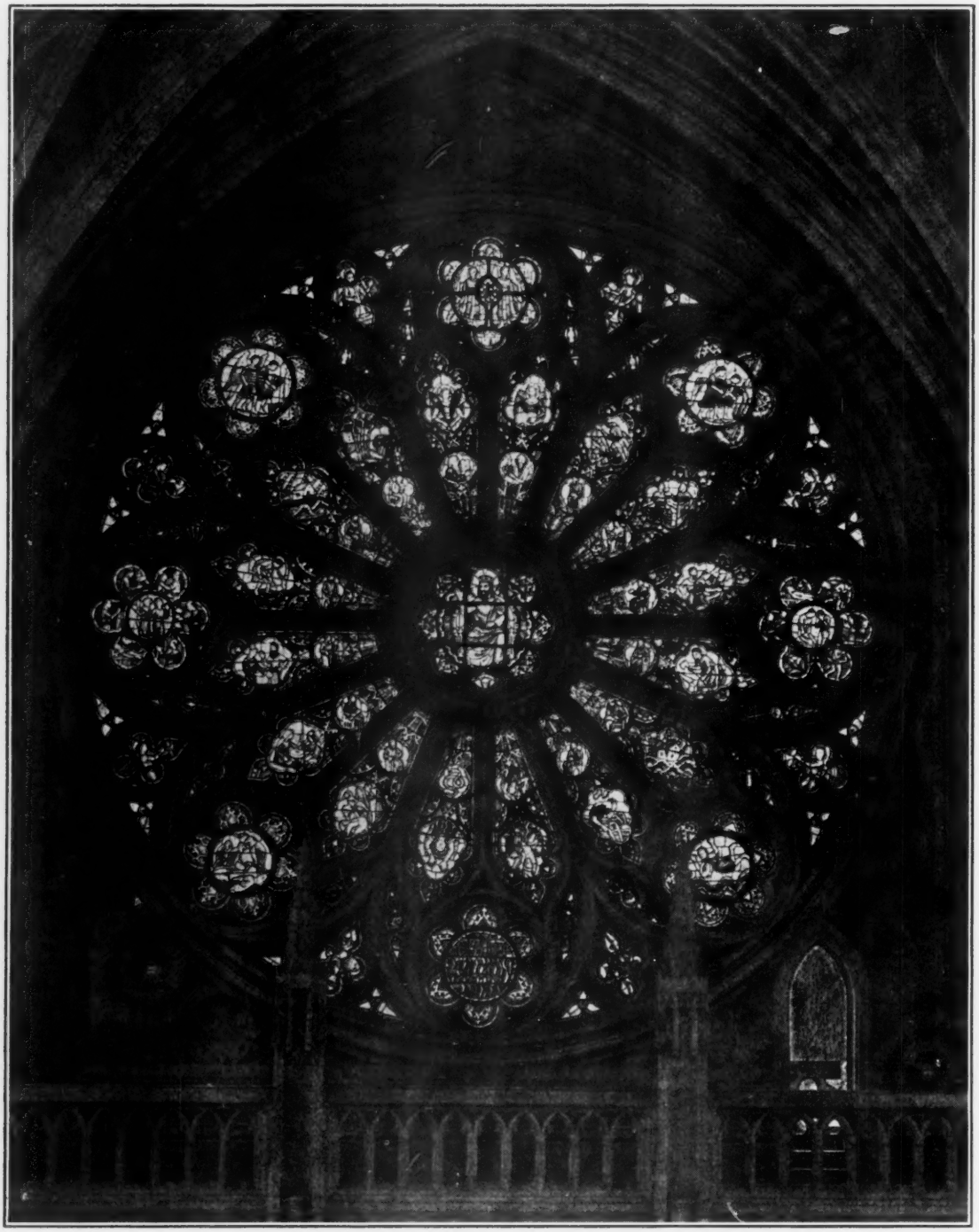

Fig. 4.—North Transept Rose Window, Washington Cathedral, designed by Lawrence Saint; Frohman, Robb, & Little, architects; photograph by Gerald W. O'Connor.

ing it necessary to choose each piece with great care.

One of the things I try to get in my windows is an "all-over effect," so that the whole window is seen at the first glance. All the great windows of the past have this wonderful quality.

I made many preliminary studies for the panel representing Isaiah, the prophet; after considering the criticisms of my assisting artists, I finally chose one which depicted Isaiah as the fiery prophet of God and lofty poet of Israel.

A window in Chartres Cathedral (Fig. 5)

Fig. 5.—Head from a window in Chartres Cathedral illustrating what is meant by archaic drawing.

illustrates what we mean by the term "archaic." The mouth protrudes farther than the nose; the ear is at the end of the eyebrow. From my standpoint this is delightfully refreshing. Many people today, however, are not pleased with this style.

To make windows as fine as possible it is necessary to test and change many pieces. The Parmelee windows have an area of 216 square feet, and out of the 6000 pieces in these three windows we changed 1200.

In the figure of Malachi, the red background is treated simply. Glass of this ancient type has a body and looks velvety at a distance.

In the figure of St. John, the streaks in the red in the halo had to be changed two or three times. At a distance the streaks run together, giving it a delightful, "juicy" sort of life and quality.

A figure of Our Lord enthroned was made for a window for a mausoleum in Norristown, Pennsylvania. The subjects treated, many of them not as large as a postage stamp, start at the beginning of the Bible and continue through the New Testament.

Description of Work Procedure

The small furnace I use holds two pots thirteen inches high. We get eighteen to twenty-four roundels out of the two pots. Reds are made in sheets to keep striations from appearing like pin wheels.

The colors may be modified two or three times before the glass is finally melted. This is a great help in matching colors accurately.

It has been an advantage to me to have several pieces of old glass with which to compare the colors.

I work the color scheme and the design along together in transparencies, color on the back and the lines on the front, so that I know from the beginning how the color patterns are working out.

The transparencies are made on celluloid with ordinary artist's colors and give the same sort of reaction that the window itself will eventually give. When a design is made in water color on paper the effect is so different from the effect of glass that the same reactions can not be obtained. Some of the transparencies are painted on canvas.

We always keep in mind the shapes of the pieces of glass so they will not break after they are put into the window. Following early precedents I try to use as few lead lines as possible. Too many small pieces of glass increase the number of leads, greatly increasing the weight and harming the window generally.

Pattern drawings show the heart of the lead line. Two tracings from these are made. One of them is cut up into patterns (each pattern numbered) and the other is used by the glazier when he puts the lead around the glass.

The patterns are made with shears with three blades which cut out a little section to allow for the heart of the lead. I use leads about three-sixteenths inch wide. The heart, of course, is very narrow. Every pattern has to be tacked down in its place like a Chinese puzzle. Selecting the glass is a most important part. We have to use the irregularities of the glass to get the best effects possible.

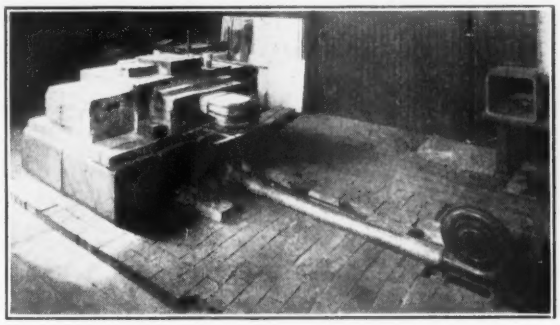

Fig. 6.—Cross-furnace designed by Lawrence Saint. The burner and blower were designed by J. Wesley Lewellen.

The patterns are laid on the glass and then cut out where the artists have marked them.

Glass Paint

The formula for paint-making is tricky. Sometimes we lose quite a lot of it. Temperatures, recorded by pyrometers, are closely guarded and carefully recorded.

Some of the oils I mix with my paint are stirred several thousand times covering weeks to get certain qualities necessary in the oil. Of course, in firing, the oil medium vaporizes and goes away before the point of fusion is reached. I use turpentine mainly.

The paint is mixed on a small glass slab and put in a thimble-shaped container into which the brush is dipped. As the weather changes the condition of the oil medium also changes.

A texture is put on both sides of the glass. Films make the light vibrate and add softness. Besides the reddish-brown, I make a brownish-black paint and a horny-toned white; admixtures make golden texture and olive, white, and warm-toned backing. The ancients used these first two colors mixed together in variations. The horny-toned white was never mixed with anything so far as I know.

In the muffle kiln used to fire the paint on the glass, the flames go up the sides through tubes. It takes several hours to fire this type of kiln to a temperature of 1160°F. After the glass is fired it has to be laid down on the drawing according to the numbers of the patterns.

The glass is kept or stored in small boxes. Every sheet carries the number of its formula.

For purposes of inspection the pieces of glass are fastened to a plate glass panel with beeswax and rosin. Black lines are painted on the back of the plate glass to imitate the lead lines.

We had to make the design of the north transept Rose in Washington Cathedral very bold so it could be seen at a distance of 179 feet. The top of it is about 85 feet above the floor. I took every section of that window to a huge barn about six miles from my studio where I could test it at distances up to 220 feet. My assisting artists conferred with me and criticized each section. All this troublesome testing and changing meant a great deal to the finished work, for when the window was put in place everything could be seen as I wanted it. In its present situation the window can not be seen to advantage. The building is not yet completed, and there is a lot of surplus light on the inside surface of the glass. The building, however, is going forward again, and the windows will soon be seen under favorable conditions.

Lead Procedure

In glazing the windows, we use lead with tin in it. The only lead which has survived from ancient times is of this type. This hardens the lead and makes it last longer. The old lead, usually three-sixteenths inch in width had a thick flange and thin heart, in contrast to much modern lead, which is just the opposite in construction. There is little of the ancient glazing that has lasted through the centuries. The paint and glass have lasted but almost none of the old lead. I have seen only two or three sections out of all the hundreds of windows made in medieval times that were still in the original lead.

The leads we use were worked out by the National Lead Company with assistance from the Bryn Athyn Studios. This is only one small instance of the many ways in which Raymond Pitcairn, Esq., has helped the art of stained glass. Mr. Pitcairn has done much for stained glass by encouraging a thorough study of the ancient, by sponsoring experimentation and research, but most of all by his artistic appreciation. I owe much of what I have accomplished to him.

Lead and various other things are mixed with linseed oil to make the cement used to fill in the space between the lead and the glass to keep out the rain. It also gives the glass a slight cushion.

In the cementing and cleaning operation, the panel is cleaned with plaster of Paris. It helps the oils to dry more quickly. We clean the glass very carefully, because even a little of the cement would affect the colors in the wrong way.

Home-made putty is put into the iron frame which in turn is fastened to the stone walls. The panel of glass is then set in this bed of putty, the covering iron is placed over the eyes, and the keys are put in place.

Huntingdon Valley, Pa.

THE MANUFACTURE OF CERAMIC DECALCOMANIA*

By G. H. Stapleford

I. Introduction

Decalcomania is the trade name given to gaily colored lithographic prints in the form of transfers. These transfers also serve for labeling where a more direct method is not feasible.

There are two kinds, "cold decalcomania" and "ceramic decalcomania." The latter, in contrast to the "cold," requires the use of high temperatures to mature its coloring and to make it permanent.

"Decals"[1] are supplied in the form of large sheets, the individual patterns being cut out and placed on the ware. An unlimited number of colors can be transferred and all of the delicacy and natural charm of color of flowers can be reproduced faithfully.

A decal consists of three main parts, (1) the printing, (2) the special tissue upon which the printing is done, and (3) the strong white backing paper which supports the tissue during the printing processes. The decal is made on tissue because that material can be made to conform to irregular surfaces. The tissue is firmly held to the backing paper without the use of any apparent adhesives. In use, the backing paper is peeled away before placing the decal on the ware.

The ware is first given a coating of decalcomania varnish which becomes quite tacky. The decal is placed in position (face down) and rubbed down with a special hard-bristled brush, and the ware is put in water. The coating on the tissue dissolves, thereby releasing the film of printing to the sticky varnish.

When thoroughly dry, the article is ready to be sent through the decorating kiln, where all the varnishes and printing vehicles are vaporized, and the colors are fused into the glaze.

Usually the large sheets of ceramic decal contain one pattern in various sizes to fit the many items in a set of dinnerware. The artist roughly designates upon the surface of each item the area to be occupied by the pattern. From this he makes tracings called "strikes," and many strikes are necessary for each set of dinnerware. Often all of the strikes required for a dinnerware set are on one large decal sheet, but when more than one sheet is required, the cost per pattern is increased. The average cost of a sheet of decals, 30 by 48 inches, is 28 cents.

Decals made for decorating in enamels (overglaze decals) are less costly than those made for decorating under the glaze because the latter are made to withstand the bleaching action of the glazes. Underglaze decals are used on ware that must withstand the strong cleansing solutions used in washing machines and may cost as high as $1.00 per sheet.

Two thousand sheets is the minimum edition that can be ordered. The cost of the original stones is spread over the estimated number of editions that possibly will be sold. The price for a private or limited edition would be much more than 28 cents or $1.00 per sheet.

In case the requirement is for fewer than two thousand sheets, the potter must take the chance of selling that particular pattern elsewhere or carry the surplus sheets.

II. How Decalcomania Is Produced

Decalcomania is printed by the lithographic process. Attempts to use other methods have failed. The lithography used differs from the usual commercial process in the art work, paper, color, printing vehicles, and sequence of printing the colors.

(1) History of Lithography

Credit goes to a Bavarian named Alois Senefelder (1771–1834) for the discovery, invention, and furtherance of lithography. He was a composer of music, and he is said to have made a search for some inexpensive method of reproducing his manuscripts. One day, while experimenting with acids and resists, his mother asked him to make out a laundry bill. He jotted it down on a stone with a mixture of soap, tallow, wax, and lampblack, which he was using as an acid resist. Later he put a border of resist around the slab and poured *aqua fortis* over the writing. He was surprised to note that after some time the writing stood out from the background like printer's type.

* Received December 30, 1935.

[1] For the sake of abbreviation the word "decal" will be used and applied to the finished, colored lithograph, as the word "transfer" is used to describe another product employed in the technical processes.

After much experimenting, he discovered the peculiar properties of this same stone: its ability to retain the grease from the soap he had used and the fact that no amount of rubbing or the application of boiling water would erase it; only by grinding could the surface be made like new.

About the same time he discovered that water would remain on the stone's surface for a considerable length of time and much longer if the stone were etched with *aqua fortis*. He also found that he could ink in the work by means of a hand-roller charged with a similar greasy ink, provided the stone's surface was kept in a dampened condition while rolling.

Thus was lithography discovered, and to Senefelder's further credit, he foresaw the possibilities in his discovery. He set himself up in business in Munich, Bavaria, as the first lithographer, and he lived to see his invention become one of the first and foremost methods of pictorial reproduction in the world.

Refinements in materials followed and new tools were devised. If Senefelder were living today, he would not recognize his own invention, except for the fundamentals.

(2) Lithographic Stones

The special stones used in lithographic printing were originally imported from the Solnhofen quarries in Bavaria, Germany. They were known as Solnhofen limestone, and were found in stratified formation from 60 to 100 feet below ground level. Originally, they were used as paving blocks. Although found elsewhere, the Bavarian stones have been considered to be the best and they command a much higher price than any other stones.

The Bavarian stones are found in different thicknesses, varying from a fraction of an inch to nearly ten inches. Stones less than $1^1/_2$ inches in depth are not used unless they possess a distinctive quality. Such a stone can be cemented to an inferior one to give it the required press strength.

Many stones have natural defects, and the most common one is the so-called chalk mark. These chalk marks appear in groups and, being of a softer texture, react differently under the acids used and prevent taking on a smooth polish. There is no remedy for this and these stones can be used only for rough or coarse work.

(3) Preparation of Stones for Art and Printing Work

Machinery has replaced hand labor in most shops for polishing litho stones.

The first step in preparing the stones is to grind them to parallel surfaces; otherwise they may fracture in the press or machine. If the grinding is done by hand, a metal tool known as a levigator, shaped like a wheel, is moved about upon the stone in a circular motion using sand as the grinding medium. This operation is continued until the surface is absolutely level; then an artificial pumice stone is used to polish and even up the texture. A water-of-Ayr stone is used to give the mirror-like polish that is required for decalcomania.

If the stone is to be used for transfer work, the surface can be slightly roughened with natural pumice stone, which is done after the water-of-Ayr stone has been used. The stone is then thoroughly washed in running water and dried either with a clean rag or squeegee. The stones should be carefully protected from dust, and it is customary to give the new surface a slight polish immediately before use.

In the general lithographic trade, the somewhat cumbersome stone has been replaced by the more convenient metal plates, zinc and aluminum. In the manufacture of decalcomania, however, stone is found to give better results, inasmuch as the damage caused by the wearing action of the ceramic colors on the work on the stone can be repaired more easily and quickly than that caused on zinc or aluminum.

Furthermore, metal plates carry a greater proportion of moisture on their surface during the run than does the stone, a feature that reacts unfavorably on the special gummed paper used.

III. The Lithograph Art Department

From water-color sketches and strikes, the lithographic artist makes finished drawings for all of the required sizes in the layout. He then makes tracings in a sheet of gelatin, laying the gelatin over the sketch and incising the lines of the pattern with a sharp tool called a needle. Small cross-marks at the corners of the tracings are used as a guide when the color separations are finally imposed upon one another.

The gelatins are then given over to the transfer department where a number of facsimiles of the tracings are made on a clean stone, upon which

the artist will make his drawings and color separations. A small amount of transfer ink is rubbed into the incisions by means of a dauber, moving the hand in a twisting motion to insure that the ink is worked into all the fine lines. Clean rags are used to remove the superfluous ink. This has to be done thoroughly to prevent scum being left on the stone when the gelatin tracing is ultimately transferred. It is then placed between damp sheets of paper and left until quite limp, in which state it is transferred to the stone under medium pressure (see section V (1), p. 386).

The gelatin can then be peeled away leaving its ink on the stone. This new image is strengthened and developed so that impressions can be obtained from it. These impressions or transfers are made in a nongreasy ink and are dusted over with a red or black chalk powder. These chalk facsimiles (called set-offs) are run down through the press onto the clean stone previously mentioned, when they are ready for the art work.

All work requiring the use of mechanical drawing instruments is then proceeded with, so as to prevent any chance smearing of the later fine hand work. It is customary to draw in the crossmarks at this stage as a precaution against their being forgotten, as they are very important.

Arm rests are placed at each side of the stone, across which a long board is supported. This is known as the sleeve-board and, as its name implies, its purpose is to prevent wearing apparel from coming in contact with the stone. Furthermore, the hand never touches the stone save at the extreme edges, as any grease would eventually print up. Care is also taken to prevent particles of dandruff from falling onto the surface, as these too will appear as dirt spots. Cleanliness is essential in this department.

The special ink, used by the artist for stone drawing and known to the trade as "tusche," is obtained either in the form of cakes or as a liquid. The edge of a cake is rubbed down onto a small saucer and the tusche thus accumulates on the saucer. It is mixed with distilled water and rubbed with the tip of the index finger of the right hand, the dish being held by the left. Mixing is continued very slowly until the ink or tusche attains the consistency of cream. If too thin, it does not impart a sufficient body of its grease to the stone and the work is rendered useless. When too thick, it will not flow freely from the pen or brush.

The materials comprising tusche are tallow, soap, wax, shellac, and lampblack. The first two ingredients supply the necessary grease, while the alkalis in the soap enable the tusche to be emulsified with water. Wax and shellac hold the tusche on the stone and allow water-soluble gum to be sponged over the work when complete, a desensitizing process which will be referred to later. The lampblack, of course, lends visibility during use.

The original design in water color, with all its multiplicity of colors, has to be resolved into the fewest number of printings and its form and modeling must also be preserved carefully. In many cases, it is found necessary to reprint a color more than once to get rich tones not obtained with a single printing. Furthermore, at times it is necessary to represent one color by three separate printings, each having a separate and distinct color. The familiar rose so often used as decoration on china exemplifies this instance. To obtain the rich, deep hues as well as the delicate tints of this lovely flower, three printings are run, each requiring a separate drawing by the artist. For the shadows, the drawing will represent a maroon, and for the delicate and gentle tints, a light pink will be printed, but the drawing on the stone will appear almost solid, save for the extreme highlights. The intermediate color requires a medium pink and it is in this drawing where the beautiful modeling of the flower is emphasized. When these three colors are printed on top of each other, all virtues of the drawings are blended, as well as the different colors used in printing, rendering the lithographic reproduction of this flower "a thing of beauty and a joy forever."

The grain of the lithographic stone is much too fine to serve the purpose of a means for shading; therefore a system of graduated dots is drawn to simulate a mechanical grain. This is known as "stipplework" and years of experience in art are required to execute this work artistically. In executing this kind of work, it is customary to fill in the solid parts of the work, running it into lines made up of a series of these dots to accentuate the modeling of the flower or whatever else the shape may take. These lines of stipple are softened off by spacing other dots in between the lines, enlarging them as they approach the shadows and reducing their size toward the light tints. Each dot has to be firm and round or, as it is said,

it must be a "printing dot"; otherwise the appearance of the shading will be blotchy and inartistic. This work must be done very skillfully and is usually a highly paid trade.

IV. The Transfer Department

A transfer system is employed because it would take too long a time and too much expense for the artist to draw every piece required on the large finished sheet. Therefore, one drawing is made for each strike and impressions are taken from it. These transfer impressions are taken from the drawing, using an ink known as transfer-ink and a specially coated paper. The coating does not absorb the ink but merely holds it on its surface. These impressions are transferred to a clean stone on a hand press. The stone is first dampened with water, which causes the impressions to take a firm hold instantly, thus preventing movement during the squeegeeing action of the press. The coating of the paper is then dissolved away by flooding the stone with water and again running the stone through the press. This forces the water through the paper, thereby releasing it. The paper can thus be peeled easily and washed away. The impressions are then treated like an ordinary drawing on stone, except that they must be strengthened first with transfer-ink before the first slight etch is given.

The above transfer system saves time and expense and is extensively used, but much skill is required to retain all details involved in the artwork and to make the finished transferred stone a complement of exact facsimiles of the original artwork.

A considerable amount of drawing may be eliminated by the use of transfers, as they can be cut conveniently and patched together, the artist repairing the breaks where necessary when they are ultimately transferred onto the stone before it is etched.

V. Tools Used in the Transfer Department

(1) Lithographic Hand-Transfer Press

This press consists of three main parts: the frame, the stonebed or carriage on which the stone is held, and the headpiece that holds a scraper against which the stone is pressed as it travels its length. The frame is made of cast iron and is strongly bolted together. The carriage is made of hardwood, strengthened by strips of steel underneath to take up some of the pressure exerted on the stone and to prevent the wood from warping. It travels on steel runners, keyed to the frame at certain distances. Directly below the headpiece and below the carriage is a steel roller, six to eight inches in diameter, which is used to take the carriage and stone under the scraper and is turned with a crank.

The roller is brought up to the carriage and lifts it by means of a lever-cam arrangement attached to the bearing on which the roller rides. The long lever is moved in a downward motion and, when working with a stone immediately under the scraper, considerable pressure is necessary to lock the lever into position. The scraper is a piece of boxwood which is supplied in 6-foot lengths approximately $3\frac{1}{2}$ inches wide and $\frac{3}{4}$ inch thick. These are cut into suitable lengths, just a fraction within the length of the stone used. The edge is V-shaped and is nicely rounded off to prevent cutting the strip of fine leather which is fastened along this edge to take up any unevenness in the surface of the stone.

Fastened to the carriage is a movable frame the same size as the carriage, which is known as the tympan. A sheet of thin zinc is stretched over the tympan to form a protection for the stone against the wearing action of the scraper. A lubricant, made from mutton tallow, gum arabic, and lampblack is smeared over the zinc.

The scraper is secured in a boxlike structure, suspended from the headpiece by one central adjusting screw only, which gives a certain freedom of movement should the stone be slightly higher on one side.

(2) The Hand-Roller

This roller is a cylindrical piece of hardwood, well turned, having two tapered handles at the ends much like the domestic rolling pin. It is 12 or 14 inches long and 4 inches in diameter, and it is covered with two or three thicknesses of flannel and also with an extra good quality leather, tightly secured at the ends to prevent undue movement when being worked. The seam along the length is ingeniously sewed together, giving a perfect circle and eliminating bulges. The rough side of the leather is out, and it is the grain which is developed to provide a fine nap for supplying ink to the work on stone. It takes many hours and days to "break in" a new roller, even for coarse work, and it is months before it can be used successfully in pulling transfers

from the work. (This "breaking in" of the roller is very important.) The roller must be handled very carefully when it has been developed because it is the most valuable asset of the transfer operator.

VI. Materials Used in the Transfer Department

(1) Transfer Paper

There are three kinds of transfer paper used: French transparent, India, and Everdamp. The transparent kind is generally used in decalcomania work, especially where close register is desired, as the tracing of the pattern can be seen through the paper when overlaying the transfer. It is a thin tissue, coated with gum and starch and a small amount of gelatin. India transfer paper is not transparent, but it has other qualities which make up for this lack. It takes a firmer grip of the work on the stone, giving a better transfer with less pressure, and it can be handled more efficiently than the transparent paper. The composition of its coating contains plaster of Paris and other materials. Everdamp paper, as its name implies, is always moist, owing to the increased amount of glycerin contained in its coating. It is used principally for pulling impressions or transfers from engravings in stone and, being damp, it retains the work for some time. Its soft texture allows it to sink into the engraving and grip the ink from the work.

Transfer paper is used to carry a fine film of special ink either from stone to stone or from paper to stone, faithfully and without loss of detail. Ordinary paper will not do this, as some of the ink would remain in the paper, thus causing the finished transfer to lack body. No paper will do this successfully by itself; therefore different types of paper are coated with a composition made of various substances, such as gelatin, starch, flour, and some resinous gums, the paper being used as a support.

The requirements of the coating are that it should not absorb the ink, it should adhere readily to the stone in one position without the slightest movement under pressure, and it should be soluble in water. Furthermore, it should be soft rather than hard, and the composition should not peel or crack off from the support.

(2) Transfer Ink

This ink contains a large amount of grease in its composition, as the transfer must take a firm hold of the stone at the slightest contact, because, unlike the artist's tusche, it has no medium to carry it into the pores of the stone. It must depend upon pressure from the transfer press and its own greasiness to fulfill its purpose.

This same virtue, however, has its own drawback, for when applied to the work by means of a hand roller, it is difficult to keep it from adhering to parts of the stone where it is not wanted, which would damage the original work. This bad feature has been overcome to some extent by mixing it with another ink, known to the trade as "crayon black," which is a companion ink to the transfer ink and is always used for best results, although some transfer men prefer to use the "rolling-up black" ink instead.

Transfer ink was once made by the printer from soap, tallow, and litho printing ink reduced with litho varnish, but the ink now obtained from supply houses can be relied on for the best results.

(3) Rolling-Up Black Ink

This is an ink not quite so greasy as the transfer ink and therefore is much cleaner in working qualities. Primarily it is intended as an acid resist in conjunction with the powders also used for that purpose. When the work has been rolled up in this ink, the powder is dusted over it to form an excellent resist. It is the first ink to be used in place of the artist's tusche after that has been washed away from the stone. One roller is kept for each kind of ink mentioned, and they are not interchangeable.

(4) Asphaltum Liquid

As an acid resist in litho work, this is unexcelled. In use, it is reduced with turpentine. It is also a good washing-out fluid, that is, for removing used ink from the work, over the film of gum. One rather remarkable feature of this substance is that it becomes insoluble in turpentine after prolonged exposure to a strong light; it was used in early experiments in photolithography.

(5) Gum Arabic

Without this material, the process of lithography would never have been discovered. When used in solution with nitric acid, its powerful action on the stone causes the stone's surface to

become ink repellent. What chemical reaction takes place is not quite understood, but it leaves a useful film behind it that is very hard to remove. It can be removed only by regrinding the stone and washing thoroughly with water, or by using an organic acid such as acetic, which, by the way, is used as a counter etch when the stone's surface is to be made sensitive to grease and ink. Gum arabic, in solution with water, has a tendency to become sour, which would harm the work on the stone instead of protecting it; a few drops of carbolic acid are therefore added to prevent fermentation. In the first etch, it is rather thin, but in the second or last etch, a thick, sirupy solution is used.

(6) Alum

A very weak solution of alum in water, washed over the clean and polished stone, allows the transfer to take on a much firmer hold, and it is used for this purpose. In combination with acetic acid it forms a good counter-etch.

A few other chemicals and materials are used in the transfer department, such as hydrochloric acid, nitric acid, palm oils, turpentine, etc. Hydrochloric acid is used on zinc as a counter etch to clean off and oxidize the zinc; nitric acid is used with gum arabic; palm oils are used for strengthening weakened work; and turpentine is a grease solvent.

VII. Preparing the Stone for Pulling Transfers

When the drawings on the stone are completed its surface is desensitized by means of an etch made from a solution of gum arabic to which a few drops of nitric acid have been added. Before applying the etch, talcum powder is dusted over the work very lightly, the surplus being wiped away, to protect the delicate work in the drawings from the biting action of the acid in the etch. The etch, applied by means of a brush or cotton, is allowed to remain on the stone for a minute or so and is then wiped down until the etch forms a very thin coating.

As it is the intention of the transfer man to recharge the work with another ink, it is necessary that the artist's work be dissolved out without interfering with the rest of the surface. Turpentine is the best solvent for this, as it does not destroy the coating of gum left by the etch. A few drops are sprinkled on the stone and the work is washed out with a clean rag. The turpentine does not dissolve the grease that has been retained by the stone; only the wax and lampblack. The gum can now be washed off and the drawings appear almost invisible; the essential part of the work, however, is still there and is never removed.

A small amount of the new ink that is to be applied is spread along the hand roller with a scraper knife and evened out on the slab until the roller puts down a fine film of the ink. The stone is then dampened with a sponge and wiped down with a damp rag and the roller is passed over the stone with a firm but even pressure until the stone is nearly dry. The stone is again dampened and the work is given a further inking-in until a strong body of ink is apparent. It is necessary that the rolling be done in an even manner so that there is a strong coating of ink over all the work, as this particular rolling-up black ink acts as an acid resist in combination with the powder resists in the next etching, which is much stronger than the first.

When the work is nicely rolled-up, talcum and resin powders are dusted over the work to form an acid resist, and the stone is sponged down with water. This does not wash off the powders, as would be imagined, but causes them to adhere more firmly to the ink, thereby forming a very strong resist. At this stage any spots or dirt can be cleaned off with scrapers or pumice-stone slips, keeping the stone dampened at the same time with the sponge.

Assuming that the etch has to be made up, it is tested for strength by putting a drop on the edge of the stone. It must not effervesce strongly; instead it must have a gentle action and open up the surface of the stone sufficiently for the gum contained in the etch to penetrate. This is an important part of lithographic work, and much experience is necessary to judge when the action is complete. The etch is subsequently washed off and the work is given a coating of pure gum which is allowed to dry.

A further etch is necessary before the transfer pulling can be done. The previous ink is washed out, therefore, either with turpentine or liquid asphaltum thinned down with turpentine, over the gum as previously described. The work is again rolled up in the same ink and dusted with the resist powders. The final etch now to be applied usually consists of a much stronger solution of gum but less acid than before. After

the application, it is washed away and the work is given a final coating of gum. It is then ready for the next step in the process, that is, pulling the transfers.

VIII. Pulling Transfers from the Prepared Stone

A separate roller is used for pulling transfers and is reserved especially for this work. This roller is carefully conditioned and has a velvet-like grain, which is essential for good work and for putting a fine film of transfer ink on the stone.

When the transfer impressions are required, the roller is first given a good scraping. The ink is then prepared, mixing one part of transfer ink with an equal amount of crayon black and reducing to working consistency by the addition of litho varnish. A little of the ink is then spread along the edge of the roller and worked on the ink slab as before.

As the work on the stone is presumably still under the gum and still in rolling-up black, this ink should be removed over the gum by washing out with turpentine. After the latter has evaporated, the gum can be washed out with clean water. Surplus moisture should be evened down with the dampening rag and the roller should be run over the stone until nearly dry. To apply still more ink, the clean sponge is passed diagonally over the stone, the dampening rag is used again, and the roller is applied once more. When enough ink is supplied to the work, the stone can be laid in the transfer press.

Having the transfer paper already cut to the required size, a sheet is laid over the work and two or three sheets of plain paper are added to serve as protection. The tympan is lowered and the carriage pushed along until the edge of the stone is directly under the scraper when the pressure is adjusted. The lever is then snapped into position and the crank is turned until the full length of the stone has passed underneath the pressure of the scraper. The lever is raised, and the carriage is returned to its original position. The transfer is carefully removed from the stone and is laid aside for further use.

During the transfer pulling, it is good practice to scrape the roller occasionally and to put on a fresh supply of ink as the roller picks up quite a lot of dust and lint from the dampening rag. The printed transfers are put away and protected from dust which would readily adhere to the wet ink, causing pinholes when transferred to the stone.

After finishing this work, the stone is regummed, and the remaining transfer ink is washed out with turpentine and again rolled up in the rolling-up-black ink, dusted with talcum powder, and stored for future use.

These transfers are one of the most important factors in lithography, as they must lose none of the details contained in the art work. Furthermore, they must not contain too much ink, as this will cause a heavy impression when transferred and will thicken during subsequent operations. It must be sharp, clear, and contain a good body of grease. This is not easy to obtain, but a good roller, well-mixed transfer ink, and care insure reasonably good results.

IX. Sticking-Up Transfers

To commence making up the large printing stones, a keystone is first made. A sufficient number of key transfers are pulled from the stone containing the artist's original keys or tracings that were made from the gelatin tracings. These are arranged in a convenient manner on a large board according to the dictations of the layout scheme. They are pasted down onto the board or fastened by means of a center punch sharpened to a rounded point. The transfer is taken up by tweezers and laid into position, the needle being used to hold it in place while the punch is used. This tool drives the transfer paper into the mounting board and holds it sufficiently secure during the fastening of the other transfers. This is by far the best method, eliminating the use of any adhesives that might injure the work or the surface of the stone when the impressions are transferred.

Four register marks are also put into position and these marks serve the purpose of attaining correct register in printing as each color is imposed. The next step is to run down the transfer tracings of the pattern onto the stone, which is developed sufficiently for taking off impressions on to large sheets that have been mounted on large sheets of zinc. The use of zinc for this purpose guarantees no shrinking of the key impression, which will be used for mounting the subsequent color transfers. Each machine stone is then made up the same way, by fastening down the transfers on top of the key impression sheet. Because transparent paper is used, the tracing can be seen, and the transfer may be laid on in correct

position. Necessary letterpress as well as the manufacturer's name is added to the first stone.

Each set of transfers is run down a specified distance from the edge of the stone to assist the machine printer to register the imposed colors. The stone is then prepared in the usual way except that the work is set more in relief than for other work (described in Section X).

X. Printing Varnishes and Driers

The principal vehicle used in printing decalcomania is lithographic burnt varnish, especially prepared for this purpose. It is made from the best quality of linseed oil which is first refined and bleached, subsequently being boiled to give it printing quality. The length of this boiling determines the viscosity of the vehicle. This quality is designated by numbers ranging from 00 to 8. Numbers 2 to 8 are most commonly used in the shops and are mixed with each other to provide the required working consistency.

As these varnishes are slow to harden or dry, a chemical drier is added to and mixed with them just before commencing to print. Its function is to oxidize the varnish and so to assist in the rapid hardening of the film of varnish printed, *i.e.*, "to dry the sheets." The chemical reagent is prepared with a medium that will readily mix with the varnish without injuring the working property of the vehicle. These driers are supplied in form of paste or liquid, each having virtues peculiar to themselves.

There is no set formula in the preparation of varnishes for printing, as weather, humidity, and heat are factors that have to be taken into consideration by the machine attendant when commencing work. A fairly stiff varnish mixture is required that will work easily and give a smooth print. If the varnish is too stiff, the print has a "grainy" look, and if it is too thin, it will not hold the color to be dusted on its surface. Experience is the best judge in this matter.

XI. Lithographic Power Printing Press

It is considered expedient to describe the most important working parts of the power press and their functions, although a detailed description is not necessary.

One of the most outstanding characteristics noticed by an observer is the sense of sturdiness and strength. This is due to the frame which has to withstand the motion of the bed in which the large stone is carried and also to the immense pressure exerted on the stone by the cylinder (amounting to several tons). This frame is held together by stays and the center bearer. There must be perfect accuracy when the frame is put together, the two sides must be perfectly level, and there must be no side sway or movement when it is fastened. It is usually cemented into concrete. The stone bed or carriage, together with the inking slab and dampening apparatus, are permanently connected and run together in a reciprocating motion imparted from the drive shaft, one end of which is connected eccentrically to a double gear, the other underneath the carriage. To provide for steadiness in running, the carriage rides on a set of huge bearings fitted into two grooved rails that are bolted to the frame.

The next important part of the machine is the cylinder which is ground absolutely true and level. It is also strengthened internally to give solidarity as it must not yield in any part of its circumference. The weight of one of these cylinders is approximately one ton. It is the function of the cylinder to roll the sheet on the stone to get the impression. The tremendous pressure necessary to do this is obtained either by powerful springs fastened to the axle of the cylinder or by means of a lever arrangement to which weights are added at the extremity of the machine. Suitable means are provided on the cylinder to enable the sheet to be placed into position for correct register. The cylinder motion is intermittent, allowing sufficient time for the operator to place the sheet on the sloping feed board, through the guide, and thence into the grippers on the cylinder. Another smaller cylinder in contact with the larger receives the sheet at the end of the cycle and places it on a set of sloping tapes through which a number of long sticks or "fliers" revolve in a semicircle and carry the imprinted sheet onto the jogging board. These fliers are made to move in time with the action of the cylinders.

The printing medium is placed in a trough at the front of the machine, and a long knife, running the full length of the duct, controls the supply of varnish or ink to the rollers which work it out into an even film on the slab provided. The rollers which ink in the work on the stone are set immediately in front of the large impression cylinder. These rollers have a steel core which is

covered with layers of flannel and finally with a special leather, and their care is important to obtain evenness in printing. Back of the cylinder are the dampening rollers which also work on a slab covered with flannel and finally with a material known as "molletin."

Setting the stone in the press is a skillful operation, as much expense can be incurred by maladjustment. There should be not the slightest motion of the stone in the bed during the run, and it must be set perfectly true and level. A spirit level can be used, as the machine itself has been set accurately when assembled in place. The work on the stone is usually a little in relief, as it would be impossible for the cylinder to get an impression off the stone by itself no matter how perfect it may be or how true the surface of the stone has been ground (see Section IX, p. 389).

XII. Wet and Dust Printing

There are two distinct methods of printing employed. One is known as "dust" printing, the other "wet" printing. In the former, the colors in the form of powders are dusted over the wet print as it comes from the press. In wet printing, however, the color is ground in the printing vehicle. Dust printing allows the maximum amount of color to be applied, whereas only a tint is obtainable in wet printing, although both have their purpose in color schemes. In some cases, where an extra depth of color is required, both methods are employed in one printing, that is, color is dusted over the "wet" printed sheet. Machines are used to apply the powder colors and also to remove surplus color from the back of sheets. A cheap grade of flour is used for the latter purpose. The two machines are similar in action and are glass enclosed to prevent the dust from dispersing about the shop, which would endanger the health of the workmen.

Wet printing does not require the use of the color machines, and the sheets are interspaced with a rough-surfaced paper to prevent offsetting, that is, the color from the face of one adhering to the back of the next. Completed sheets are placed in racks to dry, with tabs attached to give the necessary printing data.

During the printing of each color, a sheet is reserved for future reference, showing the sequence of colors. All information, such as the date and number of the last color, is appended. These sheets are known as "progressives," and their care is an important factor when another edition is required of the same pattern, so that the strength of colors can be compared.

XIII. The Varnish Stone

This is the last printing and is a covering of litho varnish all over the pattern or on parts printed by the dust method to protect the colors from being rubbed off during subsequent handling. It also elim.nates the possibility of the color adhering to the size during the process of application to the ware.

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INSTRUCTIONS FOR PRINTING CERAMIC DECALCOMANIA*

By G. M. Petersen

I. Introduction

Decals are printed by lithography from stones. The literature on lithography refers only to the general subject and contains nothing concerning the special problems of decal printing, some of which are most troublesome. Suggestions have been made on a few of the problems by some of those familiar with the process, but even with this assistance it was necessary to make many trials before a workable procedure was found. There are several factors which may influence the results, and it is sometimes difficult to determine which one is causing the trouble because its effects may not show up until the final stages of the printing are reached.

II. Ordinary Lithography *vs.* Decals

Decal printing differs from ordinary lithography in that a transparent varnish is used instead of ink for the printing, and this difference is the principal cause of many of the troubles encountered; in addition, the stone must be dry before the decal paper is placed on it. For an ordinary lithograph the print will be better if the paper or stone is slightly damp.

Zinc plates may be used for printing common lithographs, making possible the rapid offset process. They are much more convenient to handle than the cumbersome stones, but because the metal plate carries too much moisture for use with decal paper, decals must be printed from stones.

III. Outline of Routine in Printing Decals

(1) Grinding the Stones

Gray-colored stones, as flawless as can be obtained, are preferable for decals. Sand was formerly used for grinding the stones, but silicon-carbide powder is more uniform in size and cuts faster. A suitable grain size of abrasive is about No. 220 for the preliminary grinding followed by No. 500 or No. 600.

Wet the surface of a stone and sprinkle it with the powder. Place a second stone face down on the first and rotate it with a sort of figure-eight motion. The abrasive will usually need to be renewed once or twice before the surface is ground sufficiently. Wash off all of the coarse powder before applying a finer grade to avoid scratches on the surface of the stone. Grind with the fine powder, wash the stone thoroughly, and polish with a large piece of lump pumice or a polishing brick, keeping the stone wet as before. The edges of the pumice should be rounded or small chips may break off and scratch the polished surface of the stone. A smooth surface is required for drawing fine lines.

Instead of grinding two stones together, a special grinding tool called a levigator may be used on one stone or, in a plant with sufficient grinding to warrant the cost, a machine grinder or planer may be used.

After it is polished, the stone is dried and the clean surface must be carefully protected from handling; even a finger-mark may attract ink.

While grinding, the stones should be at a convenient height and where they can be readily flushed with water. One convenient method is to place the stones on slats in a shallow water-tight box near a water-faucet. The abrasive will settle in the bottom. An overflow may be provided.

(2) Tracing the Design onto the Stone

Rub the back of the drawing with *milori* blue powder. Place the drawing on a clean stone with the blued side down. Stick the paper in place with a drop or two of gum arabic along one edge or use a couple of small pieces of gummed paper. Trace the design with a hard pencil. The blue will offset onto the stone and being nongreasy will not affect the stone.

(3) Inking Outlines for the "Key"

The color "key" is a print showing in outline the areas for each color required in the printing.

A special ink called "tusche" is used for inking in the outlines. Extra fine pens are required for most of the inking. The tusche comes in stick or liquid form. Vanhymbeeck or Lemercier (both French) are suitable grades of stick tusche. German schrift tusche is sometimes used for fine lines.

The stick tusche must be made into a liquid for use: Warm a saucer or shallow dish and rub the stick over it until a good layer accumulates; add a few drops of soft water and mix with the finger.

* Received June 15, 1936.

The ink should be thick enough to work well in the pen and should be a good black color; ink that has dried out should not be used for fine work.

Before starting the inking, the edges of the stone may be coated with gum-arabic solution outside the edges of the design. This protects the stone from marking during the drawing. A support should be provided for the hand, and drafting instruments should not be laid directly on the stone. A couple of strips of cardboard at the edges of the stone may be used to keep the instruments from touching the surface.

The key design should have two or more cross-marks or register marks placed outside the design. These are used to get the paper properly placed on the stone in printing the succeeding colors.

(4) Gumming the Stone

The concentration of gum-arabic solution used in the lithograph trade is not standardized. A suitable solution was found to be 28 grams of gum in 100 cc. of water. Powdered gum will require an hour or so to dissolve; lump gum will require longer. Gum solution should be made up fresh as it sours readily. (A few drops of carbolic acid will retard souring.)

To gum a stone, pour a spoonful or two onto the surface and spread it with the palm of the hand, being sure the hand is wet with gum before touching the stone. Wipe any surplus gum off over the edge of the stone. Continue wiping with the palm of the hand until the gum is smoothly spread and begins to get sticky; then fan the stone until it is completely dry.

(5) Rolling-Up Black Ink

Because the tusche used for drawing the design will not withstand the etch required in preparing the stone for printing, it is protected with rolling-up black ink. This ink is very stiff and must be thinned for use with a little No. 00 litho varnish. Mix the ink and varnish well with a spatula on the ink slab which may be a lithograph stone or a smooth piece of marble. Roll out the ink smoothly on the slab with a leather roller.

Wet the printing stone with water, using a soft sponge to spread it over the surface. There should be just enough water on the stone to keep it moist. Roll the surface, using a firm pressure and rather slow motion. A quick, light pressure tends to pick ink off the stone. Roll the stone until the design has a good coat of ink. Re-moisten the surface if it begins to dry before the inking is completed. If the ink sticks where it is not wanted, it should be washed off at once with the sponge. Each time the roller is passed over the stone it should be shifted slightly so that a fresh surface comes in contact with the design. A less severe process, which may be preferable at times, is to rub up the design with a cloth pad charged with ink instead of using the roller.

(6) Rosining the Design

Powdered rosin is dusted over the ink, using a soft brush to spread it, to protect the design further from the etch. The surplus is brushed off. Talc or French chalk also is sometimes applied in the same manner as an additional resist.

(7) Etching the Stone

The purpose of the etch is to make the stone more receptive to the gum-arabic solution. Apparently there is much variation in the etches used by different lithographers. Some use a nitric acid etch; others a combination of nitric and hydrochloric acids; and some also add phosphoric acid. The following etch was found to work satisfactorily; 3 parts concentrated nitric acid, 10 parts concentrated hydrochloric acid, and 13 parts distilled water. The amount used varies with the size of the stone to be etched and with the strength of the etch required. For each 100 square inches of stone, use 11.5 cc. of gum-arabic solution. For a weak etch, add about 10 drops of the above acid mixture; for a strong etch, add 15 drops. With a strong etch there should be only a mild effervescence when the acid is first applied to the stone. The first etch should be a weak one. A strong etch may destroy or weaken some of the finer lines.

Pour the etch onto the stone and spread it quickly with the hand to cover the entire surface. Let it stand three or four minutes so that the acid will react as much as possible with the stone. Wipe off the etching solution with the hand, leaving only a thin film as in the previous gumming operation. Fan the stone dry.

(8) Re-Inking the Stone

To offer additional protection to the design, it should be rolled up again with the rolling-up black, dried, and again rosined.

(9) Etching with Strong Etch

A strong etch should now be applied. If any of the ink lines are weakened by the etch, a slightly weaker solution should be used or more care may be needed in rolling up the design so that it is adequately protected. It is difficult to strengthen lines that have been weakened by the etch. It will help some to ink the stone carefully and let it stand for a day or so.

If any ink remains where it is not wanted, it may be removed by grinding it off with a snake slip pencil or by scraping it off with a tool such as an oval engraving needle.

(10) Washing Out the Design

Before the stone is ready for printing, the rosin and ink must be washed off with turpentine or naphtha. The stone may be wet or dry, but in either case it must have a coating of gum arabic before it is washed out. The gum in the etching solution will be sufficient if it is dried on the stone. Sprinkle a little water over the stone. This loosens the gum over the ink. Add a few drops of the solvent, rub the inked design until the ink is loosened, and then rinse the stone well with water, removing the solvent and ink. The stone is now ready for printing.

(11) Printing with Black Ink for Color Outlines

Roll up the stone as before (Section (5)). Make as many prints as there are colors in the design. This stone may then be gummed up for storage. It should be preserved until the printing is completed as it might be necessary to prepare a second stone for one of the colors.

(12) Dusting with Offset Chalk

The fresh prints are dusted with red offset chalk. This is a nongreasy color which covers up the ink.

(13) Transferring Powdered Prints to Clean Stones

One of the prints is laid face down on a fresh stone and pulled through the press. The powder offsets onto the stone and, being nongreasy, does not affect the stone. One stone is prepared for each color.

(14) Drawing in Color Areas

With tusche, draw in the area for a single color on each stone. For some color effects, these areas may overlap in the finished print. The effect of overlapping colors must be determined by trial. The areas may be drawn in solid or they may be stippled, depending on the result desired. Gum the edges of the stone before inking.

(15) Preparing the Stone for Printing

This is done as in Sections (4) to (10) above.

(16) Printing with Varnish

The printing medium for decals is burnt litho varnish made by heating linseed oil. The grades vary from No. 00000, a very thin grade, to No. 8, a very heavy and sticky grade. Like the etch, the grade of varnish varies greatly with different printers. Some of those suggested for use were (1) strong "A" varnish reduced with middle "BC" varnish (some manufacturers use a letter system instead of numbers to designate their grades), (2) No. 8 and No. 4 mixed half and half, or (3) No. 4 boiled with gum mastic.

The grade found to work best was No. 7 mixed with 10 to 20% of No. 6. About 2 to 5% of paste drier was added to hasten the drying of the prints. A larger amount of drier causes the varnish to dry too quickly on the stone as well as on the roller.

Mix the varnish and drier thoroughly with a spatula on a slab. About one-half teaspoon of varnish will be enough to apply to the roller at first. Spread this quantity out on the slab and roll with the roller until it leaves a smooth and rather thin layer. If too much is used it will spread and tint the stone; too little varnish will cause thin prints with insufficient color. After each five or six prints (or as often as needed), add a small amount of varnish to the roller; a quantity the size of a pea will usually be sufficient.

For applying the varnish, a grained rubber roller was found preferable to leather. It does not dry the stone so quickly, it is easier to keep in condition, and it does not require any "breaking-in."

With the roller charged with varnish, proceed with the printing as with the black ink, although much more care will be required. This is the stage which will give the most trouble. A moment of carelessness may spoil the stone for further printing or at least may cause considerable extra work to clean it up again. The amount of water required is just enough to keep the surface damp with no free water standing on it. If the surface is allowed to become dry while it is being rolled, the varnish will stick and "tint"

the stone. This may usually be removed by rubbing with the wet finger if it is noticed at once. If it has taken too firm a hold on the stone, it must be removed by scraping or grinding with an abrasive pencil. The stone will then require re-etching. If the whole stone is etched, the design must be rolled up and rosined as before.

It is difficult to see any tinting while the stone is damp. If the stone shows any tendency to dry, stop the rolling and re-moisten it. Two dampenings and eight or ten rollings are usually sufficient. A trial print will show about how much rolling is required. The dampening water should be cold. Tinting may sometimes be reduced by adding a little weak etch to the dampening water. About 10 or 15 cc. of etch to a gallon of water will be sufficient.

Another method of removing tinting is to roll up the stone with black ink. The tint spots will then show distinctly. The ink is rubbed off these spots and the stone etched again. The ink is then washed out as before and the stone is again ready for printing.

Before applying the paper for the print, the stone must be entirely dry. Even a small drop of water will cause the paper to stick tightly at that spot and the paper will tear before it will come loose. The drying may be hastened by a fan.

Duplex decal paper is used in the United States. This is more sensitive to atmospheric changes than the thinner simplex paper which is preferred in Germany. Decal plants have elaborate humidity control to insure uniform size of paper sheets. This is important in securing good registration of the different colors.

Immediately after the prints are made with the varnish, they are dusted with the desired color and left to dry for a day. If the varnish is not dry when the next color is printed, it will offset onto the second stone.

The fresh prints should be placed between sheets of heavy brown paper or in shallow trays with coarse wire-mesh bottom.

(17) Preparing Stones for Storage

At the end of a day's printing or when the printing from any stone is finished it should be gummed, washed out with naphtha or turpentine, rolled up with black, and gummed for storage. If the varnish is left on the stone, it will harden and can not be cleaned off without injuring the design. Stones to be left for some time may have the ink dusted with talc.

(18) Removing Surplus Color from Prints

After the prints have dried a day, the surplus color should be removed before the next color is printed. The easiest way to remove this is to pass the sheet through some material such as whiting. This is shaken off the sheet and carries with it the loose color. Other materials suitable for this purpose are sawdust, flour, or bran.

Some colors, particularly dark browns and reds, stick to the paper worse than others. To avoid this difficulty, the color may be moistened with milk, then dried, reground, and passed through a fine sieve.

(19) Printing the Succeeding Colors

After the first color is printed, the paper must be placed on the next stone so that the colors will match up properly. The registration marks are used for this purpose. Two needles are necessary. These may be prepared by pushing the sharp point of a needle into the end of a small wooden stick, leaving an inch or so protruding. Break off the eye of the needle and grind the broken end to a blunt point.

A small hole should be made in each stone with a sharp-pointed tool at the exact intersection of the registration marks. With a needle, punch a hole through the intersection of the registration marks on the prints. Insert the needles from the back side through two of these holes. Holding the paper off the stone, insert the needles into the proper holes in the stone and let the paper slide down the needles onto the stone. Be careful that the paper does not slip before it is under the scraper of the press and the pressure applied.

(20) Sizing the Prints

After all the colors are printed and dried, a final sizing coat of thin varnish is applied. Without this sizing, the print will not adhere well when transferred to the ware. Number 2 litho varnish with 5 to 10% drier may be used for the sizing. This may be applied over the color areas of the sheet only or over the whole sheet. The latter method was found to be more convenient. A clean stone about the size of the sheet is rolled thinly with the varnish and passed through the press with the print face down on it. The sheet

must then be dried, after which it is ready for applying to the ware.

(21) Cleaning the Roller

When through with the rubber roller, it should be cleaned well with naphtha, gasoline, or benzene. If drier is used in the varnish, it may also be advisable to wash off the roller every few hours during the printing. The drier may harden on the roller and be difficult to wash off.

The process as outlined here has been found to work satisfactorily with a hand press and printing from stones 10 by 14 inches or smaller in size. The procedure used by many printers no doubt may differ in many details from that given here, just as the methods used in one plant may differ in detail from those of another.

The printing of large sheets involves the use of the transfer process to duplicate the designs. This process has not been discussed in this paper. A quite complete description of it may be found in most of the texts on lithography. The power press also involves some problems different from those met on the hand press.

Acknowledgment

Acknowledgment is made for suggestions on some of the perplexing problems encountered to W. B. Kerr, Syracuse, N. Y.; the Scammell China Co., Trenton, N. J.; Fuchs and Lang Mfg. Co., Chicago, Ill.; the Meyercord Co., Chicago, Ill.; and the Lithographic Technical Foundation, New York. The C. W. H. Carter Co. of New York also furnished samples of their litho varnishes.

Ceramic Engineering Department
Iowa State College
Ames, Iowa

ACTIVITIES OF THE SOCIETY

OPEN LETTER TO MEMBERS OF THE REFRACTORIES DIVISION

The Program Committee of the Refractories Division is setting out to build up an interesting program to be given at the Thirty-Ninth Annual Meeting of the Society.

We want you as a member, to take an active part in this Meeting and request that, if you have a paper in prospect or if you know of any member who has a report to make of some outstanding research project, you communicate with the Chairman or with one of the other members of the Program Committee.

The members of this Committee are S. F. Walton, *Chairman*, The Exolon Co., Blasdell, N. Y.; W. C. Rueckel, Koppers Construction Co., Pittsburgh, Pa.; W. R. Kerr, Armstrong Cork Co., Beaver Falls, Pa.; and J. D. Sullivan, Battelle Memorial Institute, Columbus, Ohio.

—S. F. Walton, *Chairman Program Committee*

STANDARDS COMMITTEE FOR 1936–1937

The personnel of this Committee with A. S. Watts, *Chairman*, is as follows:

(A) Definitions

R. L. Clare, Federal Seaboard Terra Cotta Co., South Amboy, N. J.
George A. Bole, Lord Hall, O. S. U., Columbus, Ohio.
Ellis Lovejoy, 480 W. Sixth Ave., Columbus, Ohio.

(B) Raw Material Specifications

F. H. Riddle, 600 Pingree Ave., Detroit, Mich.
T. A. Klinefelter, National Bureau of Standards, Ceramics Div., Washington, D. C.
S. M. Phelps, Mellon Institute, Pittsburgh, Pa.

(C) Tests

Arthur E. Baggs, Hayes Hall, O. S. U., Columbus, Ohio.
W. H. Pfeiffer, Frigidaire Corp., Chemical Lab. Plant 2, Dayton, Ohio.
W. C. Taylor, Corning Glass Works, Corning, N. Y.
G. H. Brown, Rutgers Univ., New Brunswick, N. J.
R. S. Bradley, 1005 S. Clark, Mexico, Mo.
J. O. Everhart, Engineering Expt. Sta., O. S. U., Columbus, Ohio.
A. H. Fessler, A C Spark Plug Co., Flint, Mich.

(D) Products

E. de F. Curtis, Conestoga Pottery, Wayne, Pa.
H. H. Blau, Macbeth-Evans Glass Co., Charleroi, Pa.
C. W. Gerster, Louthan Manufacturing Co., East Liverpool, Ohio.
E. H. Van Schoick, Chicago Retort & Fire Brick Co., Ottawa, Ill.
H. D. Foster, National Fireproofing Co., Haydenville, Ohio.
A. H. Fessler, A C Spark Plug Co., Flint, Mich.

ENAMEL DIVISION PROGRAM, 1937 ANNUAL MEETING AMERICAN CERAMIC SOCIETY

The Enamel Division program for the 1937 meeting is slowly taking shape. Eleven papers are promised and five more are being contemplated. Shop men particularly are urged to contribute to this program. Titles of papers should be listed as soon as possible to permit planning the program.

Nineteen cards have been received on the poll to decide the most troublesome shop problems. Shop men are urged to send in their vote on their three most serious problems. The cards returned indicate that black edge, hairlines, cover-coat blisters, adherence, shorelines, and copperheads are most troublesome. All Division members are urged to vote on these questions.

The following plan is contemplated for the 1937 Annual Meeting:

(1) February 1, 1937, is the *deadline* for receiving papers to be presented.

(2) Technical papers are to be preprinted (mimeographed) and sent out to members in advance to facilitate intelligent discussions.

(3) One day is to be devoted to a Round Table Discussion of the most troublesome shop problems, the topics for discussion being decided by the vote referred to above.

(4) The presentation time of papers will be reduced to allow more time for discussion.

STUDENT BRANCH OHIO STATE UNIVERSITY

The Student Branch of the American Ceramic Society held its first monthly meeting of the school year at Lord Hall on Wednesday, October 14. The officers elected for the coming year are John A. Tauber (Graduate School), *President;* Robert R. Long (Senior), *Vice-President;* Chas. B. Tauber (Junior), *Secretary-Treasurer;* John F. Day (Junior), *Junior Representative to Engineers' Council;* and Sidney A. Moses (Senior), *Senior Representative to Engineers' Council.*

The speaker of the evening was R. C. Purdy, General Secretary, American Ceramic Society, who gave a very interesting and instructive talk on "Fine China Made in America One Hundred Years Ago."

Refreshments and a social evening followed.

CHICAGO SECTION AND ENAMELERS' CLUB JOINT MEETING

The Chicago Section of the American Ceramic Society and the Chicago District Enamelers' Club held a joint meeting in Chicago, Ill., on Tuesday evening, October 27. The principal speaker was Francis C. Flint, of Hazel-Atlas Glass Co. and President of the American Ceramic Society.

SAILING GOOD SHIP CERAMICS ON PROGRESS RIVER

One thousand four hundred fourteen (1414) fully paid up Personal and one hundred eighty-five (185) Corporations, also fully paid—these plus thirty-two (32) who are paying as they can—a total of 1631 are sailing on the Good Ship Ceramics, bound to improve the ceramic arts, science, and technology.

WHO FOR? FOR THEMSELVES

This month the Committee reports two new Corporations, five new Personal Members, and seven new Student Members.

MEMBERSHIP STATUS

Date of Record	Members Paid		Deferred	Subscriptions	Monthly sales	Total circulation
	Personal	Corporation				
December 31, 1935	1248	187	26	488	225	2174
October 19, 1936	1382	185	32	480	200	2279
Gain or Loss	+134	−2	+6	−8	−25	+105

NEW MEMBERS

Corporation

ABINGDON SANITARY MANUFACTURING CO., R. E. Bidwell (voter), Abingdon, Ill.

GRAMMES, L. F., & SONS, INC., Carl J. Swattz (voter), Allentown, Pa.

Personal

ADAMS, FREDERICK W., 4303 Parkman Ave., Pittsburgh, Pa.; senior industrial fellow, Mellon Institute.

BENNETT, MYLES P., 1631 Gardena Ave., Glendale, Calif.; ceramic engineer, Gladding, McBean & Co.

HODGDON, MARY YANCEY, Fullerton Junior College, Fullerton, Calif.; ceramic artist.

HOUZE, ARMAND L., JR., L. J. Houze Convex Glass Co., Point Marion, Pa.; glass technologist.

NESMITH, LEONARD C., 432 W. Garfield St., Glendale, Calif.; head burner, Gladding, McBean & Co.

Student

ALEXANDER, EDGAR K., Georgia School of Technology.

BARRETT, LIONEL R., University of Illinois.

BROWN, SHERWOOD F., Canton, N. Y.

KNOX, ROBERT B., JR., University of North Carolina, Raleigh Unit.

LUTHER, HARRY E., College of Mines, University of Washington.

MAURER, JAMES A., University of Illinois.

MULQUEENY, THOMAS J., University of Illinois.

Membership Workers' Record

Corporation		Student	
W. N. Harrison	1	A. I. Andrews	2
Office	1	A. F. Greaves-Walker	1
Personal		F. H. Norton	1
B. M. Burchfiel	2	C. W. Parmelee	1
Alexander Silverman	1	W. Harry Vaughan	1
H. E. Simpson	1	Hewitt Wilson	1
Office	1		
		Total	**14**

ROSTER CHANGES DURING OCTOBER *

Personal

GERDES, PAUL E., 1907 N. Church St., Cleveland, Tenn. (Lakewood, Ohio)

MERWIN, BYRON W., P. O. Box 33, Roseville, Ohio. (Fort Dodge, Iowa)

PRESSWOOD, COLIN, Park House, Crawley Park, Bletchley, Buckinghamshire, England. (Sheffield)

THOMPSON, A. PAUL, Mellon Institute, Pittsburgh, Pa. (Erroneously listed Niagara Falls, N. Y., in October Roster.)

WEIMER, L. S., Florence-Wehrle Co., Newark, Ohio. (Beaver Dam, Wis.)

ZVANUT, FRANK J., Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio. (Rolla, Mo.)

Student

MOHR, JOHN G., Pennsylvania State College. (Ridley Park, Pa.)

TAUBER, CHARLES B., Ohio State University. (Catlettsburg, Ky.)

TAUBER, JOHN A., Ohio State University. (Catlettsburg, Ky.)

* The address in parentheses is the old address.

39th ANNUAL MEETING—MARCH 21–27, 1937

WALDORF-ASTORIA, NEW YORK CITY

SOUTHERN CALIFORNIA SECTION

An unusually interesting meeting of this Section was held October 20, with an attendance of seventy members.

After an Italian dinner the party adjourned to the plant of the Metalspray Company, Inc., at which J. C. Martin and H. B. Rice provided a practical demonstration of their development in the application of heavy deposits of sprayed metal as a means of increasing corrosion resistance, abrasion resistance, and for the purpose of replacing worn surfaces of moving machinery parts with a build-up of new metal which subsequently may be turned or ground to the original size of the part.

The process is receiving much attention throughout the United States as a means of salvaging expensive parts which have become worn. The process is of particular interest and importance to the ceramic industry in view of the abrasive nature of the dust to which clay products machinery is subjected.—THOMAS S. CURTIS, *Secretary*

PITTSBURGH SECTION

The Pittsburgh Section of the American Ceramic Society started its fall and winter schedule of monthly meetings on October 13 by acting as host to F. C. Flint, *President of the Society*, Ross C. Purdy, *General Secretary*, and Emerson P. Poste, *Chairman of the Committee on Divisions and Sections*.

President Flint was the principal speaker. In attendance at the International Congress on Glass last summer, Mr. Flint was able to make some close contacts with the human as well as the technical side of life in England and on the Continent. A large audience paid him the compliment of close attention as he described his experiences.

Racial customs, earnestness of purpose, humor and pathos, with the shadow of war ever hovering near, came and stood out bright and clear as a painting to a master's hand. And when it was done our kinship to those across the sea was evident to all.—D. G. BENNETT, *Secretary*

ANNUAL MEETING SCHEDULE, AMERICAN CERAMIC SOCIETY

Time	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Forenoon			General Session	Division Meetings	Division Meetings	Division Meetings Trips	Trips
Noon		Board of Trustees and Committee Luncheons	(1) School Reunions (2) Committee C-8	Division Luncheons	General Committee Business Luncheon Meetings		
Afternoon	Board of Trustees	3:00 p.m. Ceramic Educators	4:00 p.m. Fellow Business Meeting	Division Meetings	Division Meetings	Trips	Trips
Dinner				Keramos Dinner Meeting	Dinner Dance All Evening		
Evening		Small Concert	Get-Together Party	8:00 p.m. Installation of Officers 9:00 p.m. Orton Memorial Fellow Lecture	Dinner Dance		

SPECIAL ROOM RATES AT WALDORF-ASTORIA

MARCH 21 to 27, 1937

Single rooms (with bath): $4.50, $5.25, $6.00.

Twin bedded rooms (with bath): $7.00, $7.50, $8.25.

A limited number of larger rooms are available for those students and other persons wishing to stay three in a room. The rate will be $3.00 each person per day.

SCHOOL NOTES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A number of candidates for advanced degrees in ceramics are now carrying on research for their theses, which may be of interest to the members of the Society.

Candidates for the Doctor's Degree

J. M. Cayford is making a study of the effect of time, temperature, and atmosphere on the maturing of whiteware bodies. Bodies fired under various conditions will be carefully examined for physical properties, especially color and translucency.

H. Whittaker is making a study of the influence of the grain size of a clay on its physical properties, particularly the plasticity and drying shrinkage. The clays are separated into various size fractions, partly by settling and partly by the use of the high-speed centrifuge.

A. M. Blakely is carrying out a study of the life history of a glaze. Specimens are heated to successively higher temperatures and quenched so that the condition of the glaze and body interface may be studied petrographically. A new type of furnace has been constructed for studying the differential stress between the glaze and the body under various firing and cooling conditions. Some interesting information has been obtained on the possibility of eliminating crazing by the proper heat treatment of the glaze at a comparatively low temperature.

R. M. Palmer is making a study of the electrolytic method of casting clayware in metal molds. Preliminary work along this line would indicate that castings can be made as rapidly as with the ordinary plaster mold and of substantially the same physical characteristics. This method is particularly adaptable for making castings where fine detail is desired, because the metal molds are much more durable than the plaster ones.

S. F. Brown is carrying out a research on the effect of heat treatment on copper-red glazes and the nature of the red coloring. The determinations of the glaze structure will be carried out by means of X-ray diffraction methods.

Candidates for the Master's Degree

S. Speil is making a study of the plasticity of various types of clay as influenced by the water content. This work will be carried out on the recently constructed torsion tester for plasticity measurements which is much more precise than our previous model.

In addition to this student research, a considerable amount of staff research is being carried on. Besides the industrial problems, the following items may be of interest:

(1) A series of colored Parian bodies is being developed for small polychrome figurines. Some especially good flesh tones have been compounded.

(2) A further study of the plasticity of clays is being made using various liquids in place of the water.

(3) A study is being made, both experimentally and mathematically, of the initial period of flow of a viscous glass fiber in order to arrive at some explanation of the long period of time necessary to reach a state of equilibrium flow.

(4) A project has been started to analyze fragments of early American glass and pottery in order to give us a clearer picture of the development of these industries and to allow more positive identification. Anyone having *positively* identified fragments or damaged pieces of early American ware may send them to F. H. Norton, Massachusetts Institute of Technology, Cambridge, Massachusetts.

CERAMIC ENGINEERING MOVES AHEAD AT GEORGIA SCHOOL OF TECHNOLOGY

The Department of Ceramic Engineering at the Georgia School of Technology held the first Junior Mineral Industries School, August 31 through September 12, in cooperation with the Rotary Clubs of Georgia, the Division of Geology, the Georgia Mineral Society, and the Georgia Power Company.

Scholarships to this school were available through the Rotary Clubs of Georgia to twenty-five young men throughout the State, between the ages of sixteen and eighteen.

Six days of lectures, demonstrations, and plant and mine visitations were held, and the young students were given an insight into the mineral resources of Georgia and the southeast, the identification of these minerals in the field and laboratory, and the processing methods used in making them into finished ceramic products. The evenings were devoted chiefly to industrial motion pictures covering the plant methods of processing.

At the conclusion of this course in the Ceramic Department at Georgia Tech., the entire school boarded a special bus to visit the mineral deposits of Georgia, Tennessee, and Alabama, as well as the finest industrial plants making ceramic products in this area. The itinerary included Tate, Cartersville, Dalton, Macon, Dry Branch, and Gordon, Georgia; Chattanooga, Tennessee, and environs; and Birmingham, Alabama, and environs.

The result of this first School constituted an entertaining and educational introduction to the mineral industries. The first School was so successful that it is planned to make this an annual departmental activity.

The Student Branch of the American Ceramic Society is being reorganized and placed in active operation.

Ceramic Department Teaching Staff

Owing to the unfortunate illness of A. V. Henry, Head of the Department, it has been necessary to grant him a year's leave of absence, at the termination of which it is hoped he may be able to return to the Department. In his absence, W. Harry Vaughan has been made Acting Head of the Department in addition to his duties as Director of the State Engineering Experiment Station.

Lane Mitchell, formerly Assistant State Geologist

of Georgia, has been added to the staff of the Department.

G. W. Crickmay, Assistant State Geologist, has been added to the departmental staff as part-time instructor in ceramic microscopy.

At present there are enrolled in the department eight sophomores, two juniors, one senior, and three graduate students.

Graduate Research Problems

The researches being prosecuted by the graduate students are "Structure Control of Georgia Kaolin Refractories," "Cataphoretic Refining of Ocher, Umber, and Kaolin," and "Some Properties of Plastic Flow."

NOTES AND NEWS

THE OHIO CERAMIC INDUSTRIES ASSOCIATION ANNUAL MEETING

The Annual Fall Meeting of the Ohio Ceramic Industries Association was held in Columbus, Ohio, October 9 and 10. There was a large attendance of members and other persons interested in the topics presented at the technical sessions.

The officers of the Association for 1935–1936, reëlected to serve during the coming year, are B. T. Bonnot, *President*, Bonnot Company, Canton, Ohio; W. Keith McAfee, *Vice-President*, Universal Sanitary Manufacturing Company, New Castle, Pa.; C. Forrest Tefft, *Treasurer*, Claycraft Company, Columbus, Ohio; and Harry E. Nold, *Secretary*, Lord Hall, Ohio State University, Columbus, Ohio. Miss Ruby Byers is the Assistant Secretary of the Association.

Saturday morning, October 10, G. A. Bole gave an illustrated talk on the ceramic industries of Europe, dealing particularly with the plants which he visited on his recent trip.

General Secretary of the Society Honored

Following Dr. Bole's address, F. R. Henry, Simonds Worden White Company, Dayton, Ohio, presented to Ross C. Purdy, General Secretary of the American Ceramic Society, a Certificate of Honorary Life Membership. Dr. Henry's remarks follow.

"At this annual meeting of our Ohio Ceramic Industries Association, assembled in Lord Hall, Ohio State University, I have been commissioned and have the honor to address you at this time in our program, and I request that you now stand in order that I may make to you the following presentation:

"By being first to have the vision and to recognize the need and opportunity for making greater and more effective use of the clay resources of our Commonwealth and having a keen appreciation of the beauty and utility to be developed from such widespread and valuable resources, by availing ourselves of the facilities and personnel of our Engineering Experiment Station, you have literally made many and better clay products to grow;

"By having the initiative and giving industrious leadership, you are the acknowledged and acclaimed founder of this Ohio Ceramic Industries Association. You proposed for our research director and investigator Dr. Bole, whose worth it has been our honor to give merited recognition;

"By your appraisal and recognition of the researches and investigations carried on, because of and by this enterprise you have given fine inspiration to our ceramic education;

"By your leadership and tireless energy you have helped greatly in meeting and solving many necessary problems arising with our State and legislative authorities:

"Our Ohio Ceramic Industries Association continues a going enterprise and today we are glad to salute you and by unanimous action of our Board of Trustees we now present to you this printed expression of our good will and declare you an honored and honorable Life Member of this Association."

CERAMIC ASSOCIATION OF NEW JERSEY

The Ceramic Association of New Jersey has announced Thursday, December 10, as the date of its Annual Meeting, which will be held at the Department of Ceramics, Rutgers University, New Brunswick, N. J.

A special feature of the program will be a lecture by Francis Bowman, Advertising Manager of the Carborundum Company, Niagara Falls, N. Y.

THE ANNUAL SCIENCE EXHIBITION

The Annual Science Exhibition in connection with the annual meeting of the American Association for the Advancement of Science will be held this year in the Atlantic City Auditorium, December 28 to 31, 1936. Among the research exhibitors will be four or five Nobel Prize winners. C. G. Abbott will show his improved solar engine. R. J. Anderson will show chemicals produced by tuberculous. Distinguished institutions and societies will have exhibits and demonstrations among which will be the Bartol Research Laboratory, American Medical Association, American Dietetic Association, National Bureau of Standards, Rural Electrification Administration, Smithsonian Institution, American Pharmaceutical Association, and American Institute of Physics. The exhibitors, including publishers who serve science in many ways, will have the most extensive displays that they have ever shown.

The Science Library will have practically all the 1936 science books. A decorative sign in this Library will read "Books Are to Science What Iridescence is to the Pearl." Another decorative sign quoting from Schuster will read as follows: "The History of Scientific Discovery is to a Great Extent the History of Scientific Instruments and Appliances." A third sign may be used over an industrial exhibitor's booth as follows: "A Product of Science Extending Usefulness and Luxury to an Ever-Increasing Number of People."

STUDY HOURS ON COLOR AND DESIGN AT THE METROPOLITAN MUSEUM OF ART

The Museum's annual series of Study Hours on Color and Design, offered in 1936–1937 for the twentieth season, comprise free public courses on Sundays, Tuesdays, and Thursdays, members' courses on Mondays and Fridays, and a special course for teachers in the public schools.

As heretofore, all these courses are continuous through the season; some, however, consist of sequences of short courses complete in themselves and readily taken as separate units. Thus the course, Design in the Decorative Arts, offered Tuesday mornings, consists of lectures and gallery talks arranged in three groups. There will be one group of eight lectures devoted to general study of design and two shorter groups of four lectures each, dealing respectively with design in wood and in textiles. A similar arrangement is followed in the short course on color, offered Tuesday afternoon, a general study of color, followed by special studies on color in ceramics and the painter's use of color.

On Thursday afternoons, only four-lecture courses will be given. These offer opportunity for examination of special fields and will interest persons who have limited time for Museum study. One of these short courses is entitled Design in Contemporary Decorative Art; another, Design and Color in Dress.

Members' lectures are again arranged in group sequences: Monday afternoons, a general series on the decorative arts, followed by a special series on design in the graphic arts and on design and craftsmanship; Friday afternoons, a general series on design, supplemented by shorter courses on design in wall coverings and in rugs.

Continuing the method found satisfactory last season, the Monday afternoon course for members will be planned so that small groups may be formed for specialized study, in which any who wish to make objects in techniques which they already know will be given guidance in design and color and in the selection of motives from the collections.

The long course, Sunday afternoons, will include a number of outside specialists, among them Harvey Wiley Corbett, on design in architecture; Francis Lenygon, on interior design; Nancy V. McClelland, on wallpaper; Eugene Schoen, on modern materials of decoration; Alvin L. Powell, on light in design; Gertrude Cheen Robinson, on combining decorative styles; and Hildreth Meière, on design in rural decoration. Pauline Simmons and Joseph Downs of the Museum staff will also speak in this series.

During the months when the Neighborhood Circulating Exhibitions are on tour (October through June), one or more study hours on color and design will be given at the various locations where these collections are shown. Among the titles of such talks are design and color, lessons from Near Eastern art, color facts taught by the art of China, and Japanese prints and textiles, a study in design.

In the study hours on color and design, the method is first to discuss the elements of design and the principles of color revealed by analysis and comparison of Museum pieces brought to the classroom for such demonstrations and, in subsequent gallery talks, to rediscover and confirm them in many other forms, materials, and styles of art, by such means providing the Museum visitor with simple practical aids toward enjoyment of the collections.

CERAMIC EXHIBIT AT WALTERS ART GALLERY

One of the largest exhibitions of ceramics as well as one of the most representative of the best period of this craft in Greece, Rome, medieval Persia, and China was held at the Walters Art Gallery, Baltimore, in connection with the meeting of the Art Division of the American Ceramic Society on October 30 and 31.

In addition to the large number of Greek and Roman vases permanently shown in the Gallery, about fifty included in the Walters Collection were selected for exhibition. An interesting feature of many of these pieces of pottery is that, like similar relics of ancient Greece, they have been over-painted and the original luster and design have been covered to conform to the taste of a later, usually a 19th Century, artist. During this past summer the over-painting has been eliminated in the Walters Museum laboratory, and the vases now appear as they came from the hands of their original designers and makers. On one vase this elimination was made on only one half of the object so that a comparison between the original luster and the later work might be made.

The items displayed included Greek pottery from the 6th and 5th (?) Centuries B.C. to the fall of the Roman Empire.

One section of the exhibition was given to the different techniques, showing the red- and black-figured potteries and the various glazes. A table with vases, urns, cups, and other objects was laid to portray the setting of a Greek dinner party. Two tables, one showing paintings of daily life and the other stories of Greek mythology and religion, were among the unique features of the show. There were also a number of Tanagra figures on exhibition.

The exhibit of medieval Persian pottery was a splendid exposition of the range and characteristics of the products of the potter's art from this country. In date, it extends from the 10th to the 15th Centuries and includes rare pieces of luster in cobalt, turquoise, and minai ware, products of the kilns which scholars are now able to locate with some certainty in such regions as Rayy, Kashan, Sultanabad, and Kubatchi.

For many years the Walters collection of Chinese pottery has been famous, and from this collection the finest pieces were chosen for this special exhibition. In this group were the delicate peachbloom which, while not a large group, includes some of the finest specimens of this type, the brilliant red pieces known as ox-blood, a collection of pieces of various hues described as transmutation, celadon, white porcelain, exquisite turquoise, polychromes, the popular blue and white, and other products of the potter's skill.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS, LONDON CONGRESS, APRIL 19 TO 24, 1937

For those interested in concrete, natural stones, and ceramic materials, the Congress of the International Association for Testing Materials, which is to be held in London in April, 1937, will be of considerable importance. Ceramic materials, the general testing of ceramic materials, the strength and testing of brick and tile, refractories, electrical porcelain, and the classification of clays will be dealt with.

The last Congress for Testing Materials was held in 1931, and every effort is being made to insure that the knowledge in this most important field will be brought completely up to date. It is of interest to note that the papers will be presented in the form of summaries, so that a vast amount of information will be made available in easily accessible form. Further details relating to the Congress will be published as they become available. Inquiries should be addressed to the Honorary Secretary of the Congress, K. Headlam-Morley, The International Association for Testing Materials, 28 Victoria Street, London, S. W. 1.

COMMUNICATIONS—CERAMIC HISTORY

COMMODORE S. O. RICHARDSON, JR.

Commodore S. O. Richardson, Jr., was born at Wakefield, Mass., in 1864. His father, Dr. S. O. Richardson, and his mother, Abbie M. (Foster) Richardson, both of old New England families, gave to him those wonderful qualities which later developed him into the ideal citizen, a clear thinking and perfectly balanced business man, a humanitarian, and a sportsman of the highest rank.

In 1881, Commodore Richardson entered the employ of the New England Glass Company and started his eventful career. In 1888, when the Company moved its plant to Toledo, Ohio, and became known as the Libbey Glass Company, Commodore Richardson became Secretary of the new company.

In the early 90's, a branch plant was established at Findlay, Ohio, with Commodore Richardson in charge. A most significant event developed at this plant during a strike of boys, when Commodore Richardson suggested to M. J. Owens, who was then acting as factory manager, that an apparatus could be developed to handle the molds without the boys. Mr. Owens called in the assistance of Mr. Wade, blacksmith at the plant, and in a few days then presented to Commodore Richardson the results of their work. They had been unable to develop the proper mechanical motion, which idea was supplanted by Commodore Richardson. The first dummy was soon perfected, and this machine has been in use ever since.

This development marked the real initial inventive genius of M. J. Owens and was the beginning of an era destined to revolutionize the glass industry. It was also a remarkable coincidence that three such men, M. J. Owens, a man of inventive ability and a practical glassworker, E. D. Libbey, a man of wide vision and keen business ability, and S. O. Richardson, Jr., a practical business man and experienced glassmaker and factory manager, and a man of inventive ability, should work toward a common end. And it is not surprising that at the Libbey Glass Company the foundations were laid for the most revolutionizing developments of the glass industry.

In 1893, the Libbey Glass Company erected at the World's Fair in Chicago an exhibition one-furnace plant, operated by M. J. Owens. Here again the business ability of Mr. Libbey and Mr. Richardson was shown, and under the able management of Mr. Owens the American people saw the developments of an almost unknown industry. This rather spectacular exhibition made Libbey products known in every household, and we still hear of the glass-woven dresses worn by Georgia Cayvan and Princess Eulalie.

This exhibition paved the way for a tremendous development of the Libbey Glass Company and made possible the immense expansion which followed and in which each of these men played a characteristic part.

Commodore Richardson was an outstanding figure in the glass world. Few men ever served in such detail in the various branches of an industry. He was equally at home as an executive, a salesman, a glassmaker, and an inventor, and it was this rare combination that made it possible for him to see the dawn of a new day in the manufacture of glass.

The early experimental work of Mr. Owens was conducted at the plant of the Libbey Glass Company, Mr. Richardson and the mechanical staff of the Libbey Glass Company assisting in the development of the work. The original paste-mold machine of Mr. Owens was built and tested out at this plant.

When Mr. Owens developed the revolving tank, in connection with the bottle machine, there was great difficulty in developing a spout to carry the tank glass into the center of this revolving member, and the glass was always very seedy. The spouts were made at the plant of the Libbey Glass Company, and one day while Mr. Owens was at the Libbey plant he was notified by phone call that another spout had broken and that, as usual, the glass was full of blisters and seeds. In despair Mr. Owens was at a loss for the next step. He spoke to Commodore Richardson and several other of the Libbey men, and Commodore Richardson suggested that the glass be allowed to flow from the broken spout directly upon the side of the revolving tank, and Mr. Owens, following this suggestion, found that it solved the spout trouble, and also the matter of seedy glass. This was the beginning of good glass production for the machine and was another illustration of the coöperative spirit shown by these men so dramatically united in business.

In the early 90's, Mr. Richardson foresaw the necessity of a machine for blowing electric light bulbs, and in 1907 the Westlake Machine Company was started to develop a machine for this purpose. Mr. Owens and Mr.

Bock, who was associated with Mr. Owens in the development of the bottle machine, were to design this machine. Within a short time, however, Mr. Owens and Mr. Bock withdrew and Mr. Kadow, formerly with Mr. Owens, became associated with the Company. S. O. Richardson, Jr., personally superintended this new development work. In common with the Owens bottle machine a vacuum process was used to gather the glass, but an entirely different process must necessarily be used for the lead glass from which all bulbs were then made. Mr. Kadow looked after the mechanical design and it was found that the glass level must be kept within very constant limits. Mr. Richardson personally designed and developed the process and furnaces for this work and took out patents upon the method.

The developments of a machine of the Owens bottle type, the Westlake bulb machine, and the necessary equipment for operating required an immense outlay of capital and unbounded faith in the ultimate success of the process. The success of the Owens bottle machine can be credited to Mr. Libbey and Mr. Owens, and the success of the Westlake bulb machine to the imagination and daring of Commodore Richardson, and the faith he instilled in his business associates.

After the Westlake bulb machine was proved a success, the Libbey Glass Company built a machine plant at Sandusky, Ohio, where the unqualified success of the installation was proved. This machine has almost entirely displaced hand blowing in this country.

Under the able leadership of Commodore Richardson in the development of the Westlake bulb machine, marked advances were made in the scientific study of glass and refractories and temperature control, which factors were of great assistance in the development of the glass industry in general. It was found necessary to make most careful studies of glass flows, temperature control of furnace and glass, chemical and physical characteristics of glass and refractories, and to blaze a trail of information now available to the industry as a whole. It was in this transitory stage that the resourcefulness, ability, and tenacity of purpose of Commodore Richardson carried the day.

Following the development of the Westlake Bulb machine, Edward Danner, at the Libbey Glass Company, was instructed to undertake the development of a design for a tube-drawing machine. A continuous process seemed to be impossible, but again the imagination of Commodore Richardson saw the way. He worked with Mr. Danner, gave him all possible encouragement, and in the face of most discouraging developments, never wavered. Even after the mechanical operation of the machine was perfected, the glass was unfit for use, and a complete study of glass from both the physical and chemical aspects must necessarily be made. Here again the creative spirit of Commodore Richardson asserted itself, and he developed furnace and temperature conditions suitable for the work. His intimate knowledge of the physical and chemical nature of glass, together with his ability as a glassmaker, served him well. As a result, the Danner tube machine was successfully developed, one of the simplest, most perfect, and most revolutionizing glass machines yet produced.

The achievement of Commodore Richardson will go on record as having had a decided bearing on the glass industry. In common with E. D. Libbey, M. J. Owens, and J. D. Robinson of the Libbey Glass Company, a business of such financial proportions was built up that with this as a nucleus, the development of the greatest mechanical changes in the glass industry was made possible.

Commodore Richardson worked in a quiet, modest way, but with his inspiring personality and smile led men through difficulty and trouble. His power of leadership and organization was decidedly developed and his unselfish interest in the work of others made him a most important factor in development and research.

The achievements of Commodore Richardson were not limited to the bulb and tube development; his early success as a maker of fine glass for cutware was followed by notable colored glasses, railroad ware, optical glasses, chemical glasses, and gage and heat-resistance ware; in fact, there are few types of glass manufactured that have not been mastered by him.

Few men have developed such all-around ability and have participated in such a general development of an industry as had Commodore Richardson. The imprint of his ability and character will always be recognized in the modernization of the glass industry.

Commodore Richardson enjoyed that rare, entire development as a business man, a family man, a citizen, a lover of the artistic, and a sportsman.

Commodore Richardson never associated himself with a political movement, but took a most active interest in city, state, and national matters, and was often appointed to special committees on matters of importance to the city and state. During the World War he was very active and occupied many important positions in the developments of those days.

His activity as a humanitarian was extended, but in this sphere he worked quietly and preferred to remain in the background. His advice, sympathy, and help were given liberally, and a chat with the Commodore was always heartening.

His business activities extended to many other fields; besides his association with the Libbey Glass Company, he was President of the Richardson Company, President of the Fifty Associates Company, a bank director, a trustee of the Northwestern Mutual Life Insurance Company, and a lay trustee of Notre Dame University. He was President of the Association Island Corporation from the time of its inception to the time of his death.

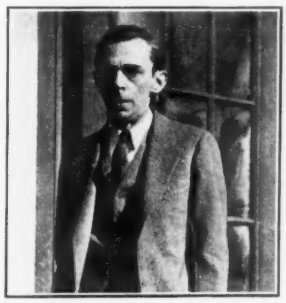
No man on the Great Lakes has ever borne the love and universal admiration that was accorded to Commodore Richardson. He was instrumental, not only in fostering and developing yachting in Toledo and the Great Lakes, but through his efforts international racing on the Great Lakes has been developed and perpetuated, and at present the Richardson Trophy is the representative trophy under competition by Canada and the United States.

Commodore Richardson showed as a sportsman the same open, clean, fair, and wholesome spirit that he evidenced in his business, in his home life, and his community, and in his passing he has left a monument of love, spirit, and human example never to be forgotten.

—HENRY W. HESS

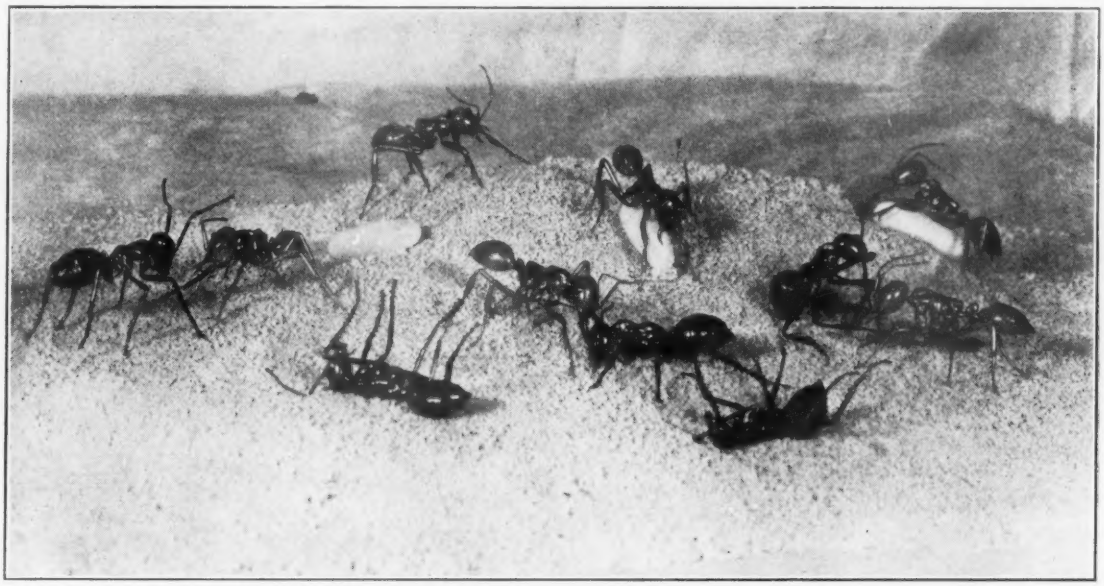
FRANK LONG'S GLASS MODELS OF THE INVERTEBRATES

The Carnegie Museum of Pittsburgh, Pennsylvania, is one of the few museums in the country fortunate enough to have exhibits which make use of the unique properties and effects obtained from modeling in glass. The accompanying illustrations represent the general nature of the invertebrates which are on exhibition in the Museum. The preparation of these exhibits was started a few years ago under the direction of the Director of the Museum, Dr. Avinoff, when he obtained the services of Frank Long.



Frank Long

The construction of these models requires the rare combination of a skillful glass-blower and a natural artistic aptitude. Mr. Long started glass-blowing in the making of laboratory apparatus. Later, through his interest in the microscope, he began the making of models of plant and animal life. The equipment used in such work is unbelievably simple, and the results are almost entirely accomplished by skillful manipulation. It is, of course, essential that the models be lifelike reproductions as to form and proportions and often on



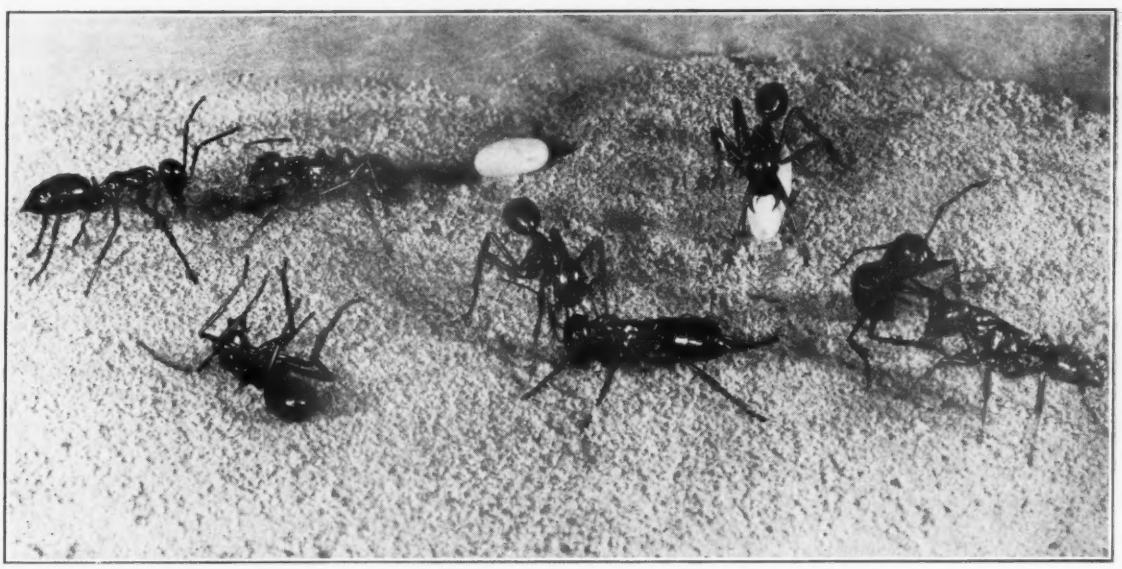


FIG. 1.—Red Amazon (lighter color) and common black ants. Modeled 9 times their size or about 3 inches. These are part of a group which will show a battle between the fighting Amazons and the blacks. The Amazons steal the eggs of the blacks and raise the young to become their slaves.

a highly enlarged or reduced scale, but they must also be lifelike in color, texture, and quality.

Rods and tubes of ordinary soft glass are used for the work and, in some cases, colored glass, as in the case of the colonial jelly fish. Although such delicate models as the ants are made entirely of glass, it does become necessary at times to make use of Canada balsam such as is used in assembling the hundreds of flower-like structures of the jelly fish which could not have been assembled by heating.

Those interested in ceramics should make a point of seeing these exhibits, as well as those which are offered in the American Museum of Natural History in New York, the Buffalo Museum, and the Harvard Museum of Comparative Zoölogy. The exhibit at Harvard contains the work of the Blaschke family who have been making models in glass for three generations.

—STUART M. PHELPS, *Mellon Institute, Pittsburgh, Pa.*

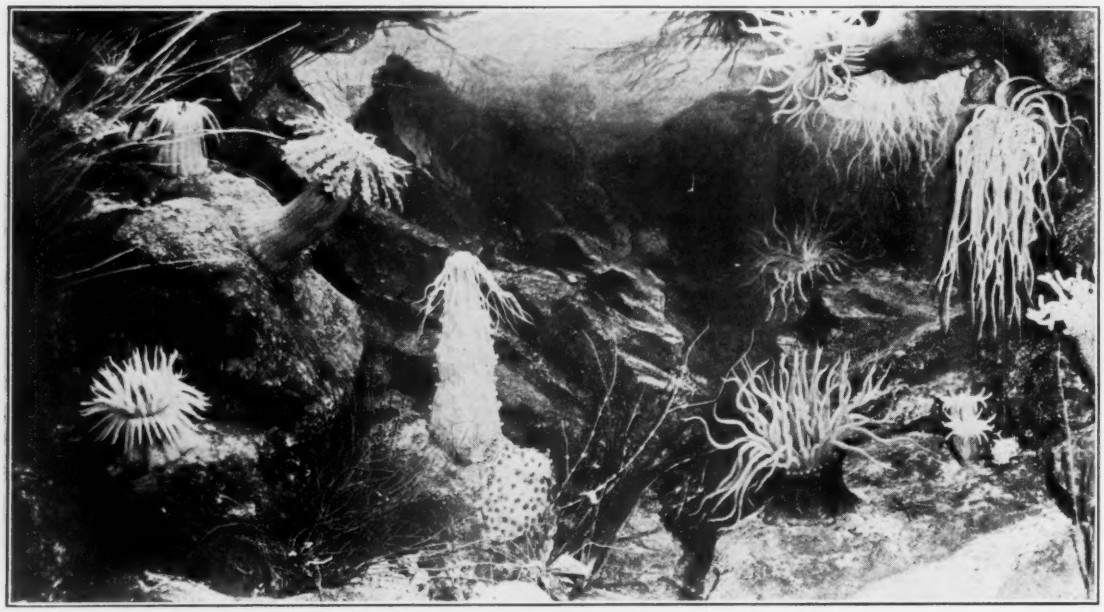


FIG. 2.—One of the finished exhibits in Carnegie Institute which is modeled mostly in glass. These sea anemones are in beautiful colors and are arranged in their natural setting of the tidal shallows of the Bay of Naples.

FIG. 3.—Colonial form of jellyfish made about eight times its natural size. Comprised of red, yellow, and clear glass. Approximately 15 by 18 inches.

Making Glass Models of Plant Life and Invertebrates

Mr. Long gives the following brief account of this interesting and rare work.

"It is a striking illustration of the versatility of glass that it may be used successfully in the construction of models of the invertebrates. My first experience in glass-blowing was acquired during the war when the demand for laboratory apparatus was very heavy. My interest in the microscope (and having the equipment to blow glass) led me to experiment in copying the curious forms of the life it disclosed, for the most casual glance through the microscope reveals the glass-like appearance of the majority of the plant and animal life viewed. Another characteristic is the design or the expression of formal structure, a feature that permits of these forms being modeled in glass. Tubes of common soda glass and rods offer the raw material from which the models at the Carnegie Museum are constructed. Workers in ceramics and chemists who make their own laboratory apparatus acquire the technique fundamental in building these models.

"The heating of the glass is done on the blast flame. The essential tools are very simple, consisting of little more than a few round and flat carbons and a pair of tweezers to draw and shape the hot glass. Softness of line is easily obtained for the contours are not lost as the glass cools. Such soft-bodied animals as jellyfish acquire a most natural appearance when made in glass. Curves may be described that chill rapidly in the position desired and local applications of a small flame permit the welding on of projecting pieces.

"In the construction of the ants illustrated, the head, thorax, and abdomen are made first, then the legs These parts are welded together in a small needle-point flame. The fragile antenna are added last. The chief concern of the glass-blower, as the model nears completion, is to manipulate it before the flame without endangering the delicate spines on the legs.

"The colonial jellyfish was made of colored glass throughout. In this complex model, it was necessary to use Canada balsam for cementing the parts, as the hundreds of flower-like structures of which it is composed would not have withstood the 'spotted' heating necessary to weld them together.

"This work in glass, started under the counsel of Dr. Avinoff, has proceeded for several years at the Carnegie Museum. To bring before the public eye the bizarre world of the invertebrates is, I feel, a worth-while task."

—Frank Long, *Carnegie Museum, Pittsburgh, Pa.*

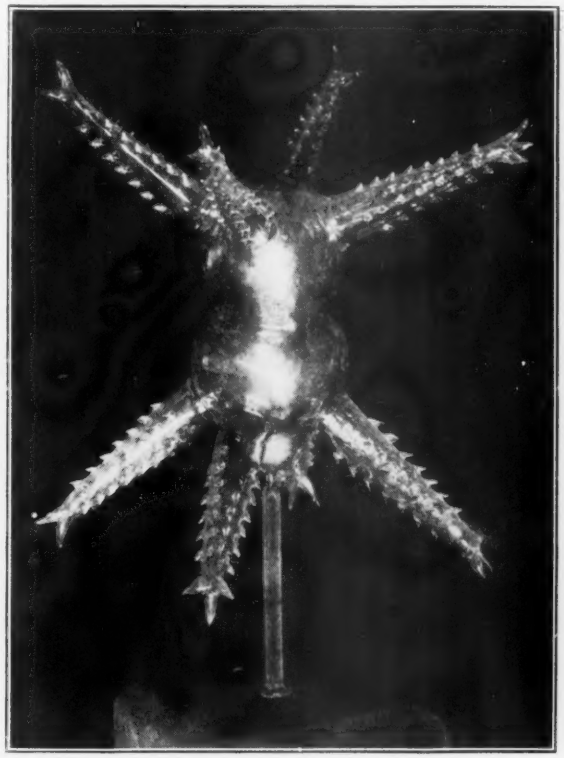


Fig. 4.—Primitive plant model of microscopic size in life. The model measures 7 inches high and is constructed like a thermos bottle, the inner part, not clearly shown, is of green glass and the outside is of clear glass.

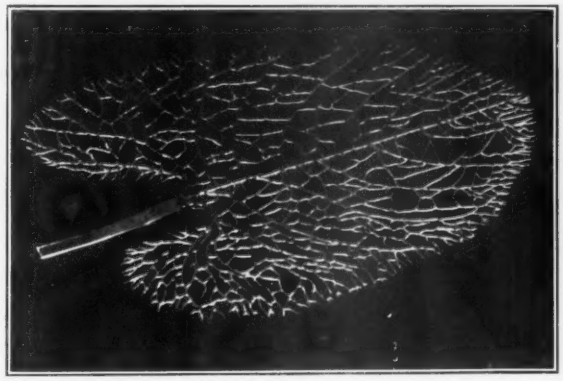


Fig. 5.—Veining of a leaf made of green glass; about 7 inches long.

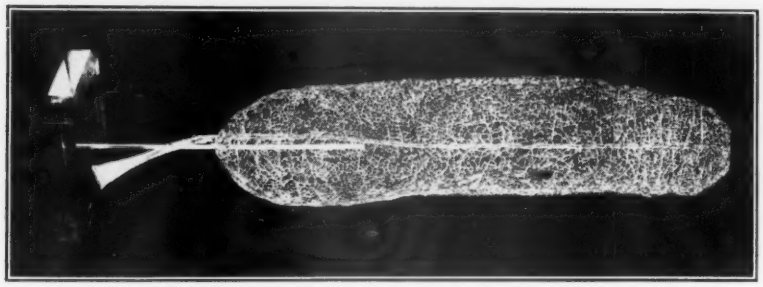


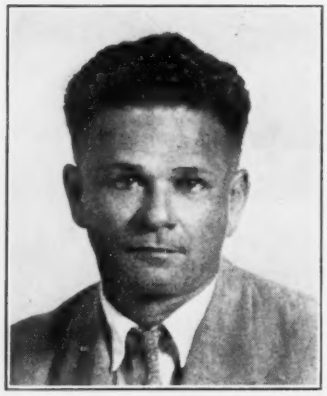
Fig. 6.—Model of a mold spore which occurs in nature about $^{1}/_{16}$ inch in height. The model, about 14 inches high, is made of clear glass with small amber-colored beads covering the outside.

ROBINEAU MEMORIAL CERAMIC EXHIBITION PRIZE WINNERS*

Glen Lukens and Paul Bogatay Win First Prizes

Prize awards for the Fifth National Ceramic Exhibition (The Robineau Memorial) at the Syracuse Museum of Fine Arts, Syracuse, N. Y., were announced at the preview held Friday, October 16.

To Paul Bogatay was awarded the $100 prize for ceramic sculpture offered by the Ferro Enamel Corporation, Cleveland, Ohio. Mr. Bogatay is an instructor in design at Ohio State University, Columbus, Ohio, and also associated with the Ford Ceramic Arts, Incorporated. He was the winner of the ceramic sculpture prize in the Fourth National Exhibition in 1935, with his ceramic sculpture, "Native Woman."



Glen Lukens

Glen Lukens was awarded the first prize for pottery of $100 offered by the Onondaga Pottery Company of Syracuse, N.Y. Mr. Lukens, who is head of the Ceramic Art Department of the University of Southern California, Los Angeles, California, entered a group of three pieces. He is a member of the American Ceramic Society.

The second prize for pottery, $50.00, offered by the B. F. Drakenfeld Company, New York, N. Y., was awarded to Maija Grotell of New York City, for a group of five pieces.

H. Edward Winter, Art Director, Ferro Enamel Corporation, Cleveland, Ohio, was given a special prize of $25.00 for a green enamel punch bowl.

Honorable Mentions for pottery were given to the following: Dorothea Warren O'Hara, Darien, Conn., for a carved bowl; Harold E. Riegger, New York State College of Ceramics, Alfred, N. Y., for a gray and red plate; William E. Soini of Brooklyn, N. Y., for two blue bowls.

Honorable Mentions for ceramic sculpture were given to the following: Waylande Gregory, Metuchen, N. J., for "Sun Bathers" and "Polo Players"; Russell Barnett Aitken, Cleveland, Ohio, for "Europa" and "Baby Faun," loaned by the Walker Gallery of New York City.

The Jury consisted of Richard F. Bach, *Chairman*, Director of Industrial Relations, Metropolitan Museum of Art; Arthur E. Baggs, Professor of Ceramic Art, Ohio State University; R. Guy Cowan, Onondaga Pottery Co., representing the American Ceramic Society; William M. Milliken, Curator of Decorative Arts and Director of Cleveland Museum of Art; and Anna Wetherill Olmsted, Director, Syracuse Museum of Fine Arts.

With this Fifth National Exhibition, a special exhibition of Contemporary American Ceramics, assembled by the Syracuse Museum by official invitation from Denmark, Sweden, and Finland, was shown only at the Syracuse Museum before shipment abroad.

After the judging and the final check-up of the invited pieces for the foreign bookings, Mr. Milliken, speaking for the Jury, issued the following statement.

"American ceramics have come of age. The exhibition assembled by the Syracuse Museum of Fine Arts, which is to go to four cities in Europe, demonstrates this fact in no uncertain fashion. The Fifth National Ceramic Exhibition is also first-rate in quality. The Jury was tremendously impressed by the high level of achievement and by the variety and quality of the pottery, ceramic sculpture, and enamels. America has never had so comprehensive an exhibition before and it was the feeling of the Jury that no European country could show an exhibition of greater comprehensiveness of quality today."

Pottery (in group of five pieces) by Maija Grotell, New York, N. Y., awarded second prize for pottery ($50 given by the B. F. Drakenfeld Co., New York, N. Y.).
(1) Bowl (white horses); (2) bowl (deer, gray and lavender); (3) bowl (leaves, turquoise and gray); (4) and (5) vases (geometric, brown and tan and brown and yellow).

Richard F. Bach

Richard F. Bach of the Metropolitan Museum, New York, N. Y., said "The National Ceramic Exhibition at the Syracuse Museum of Fine Arts demonstrates consistent advance in artistic merit and ceramic skill. The Fifth Annual Exhibition reveals a satisfying standard of quality as to form, color, and understanding of material representative of American ability and comparable with modern work in Europe.

"That four cities abroad should invite an exhibition of work by American potters; that outstanding American museums should gladly coöperate by lending exceptional pieces of modern American pottery; and that several well-known art museums in the east and in California should welcome an opportunity to display a collection of recent American pottery and ceramic sculpture—these are the endorsements that mature skill, patient training, and thorough knowledge have brought to this important type of art in our country."

* Photographs of the prize-winning pottery and sculpture will be shown in the December issue of *The Bulletin*.

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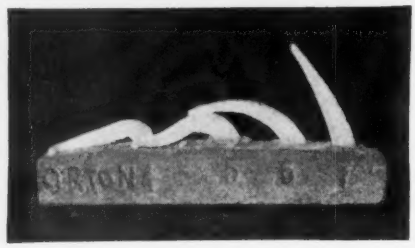

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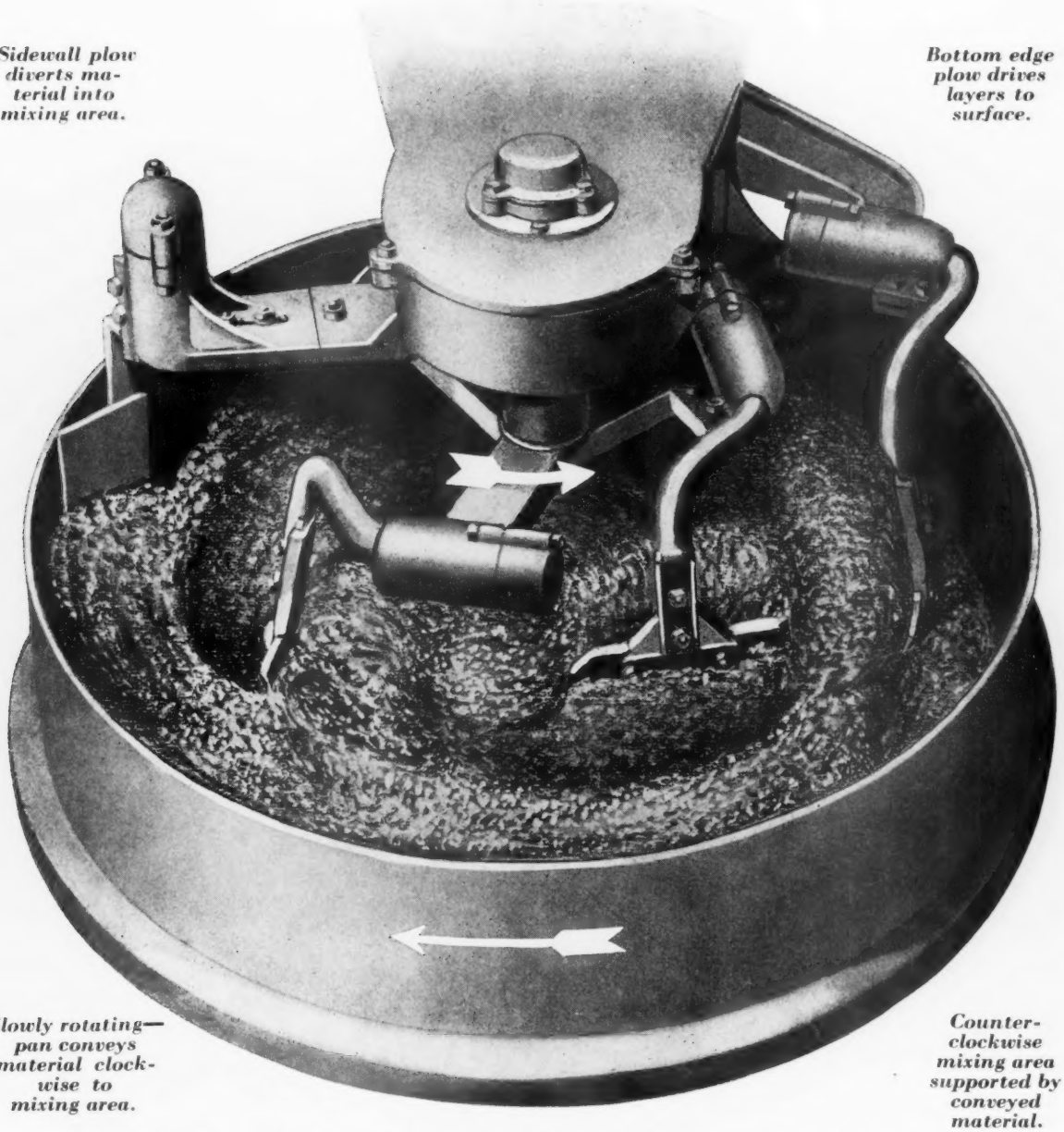

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